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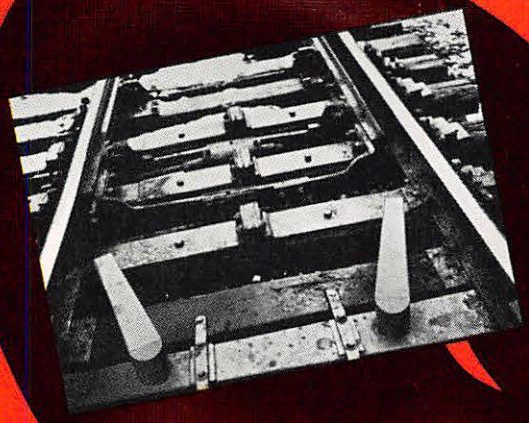

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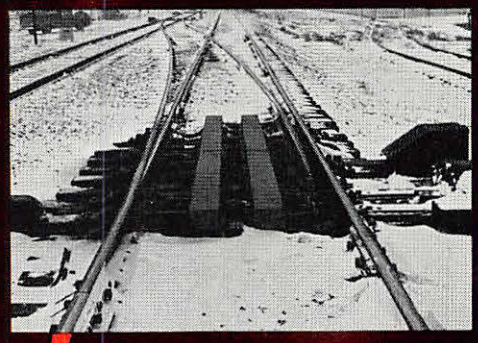

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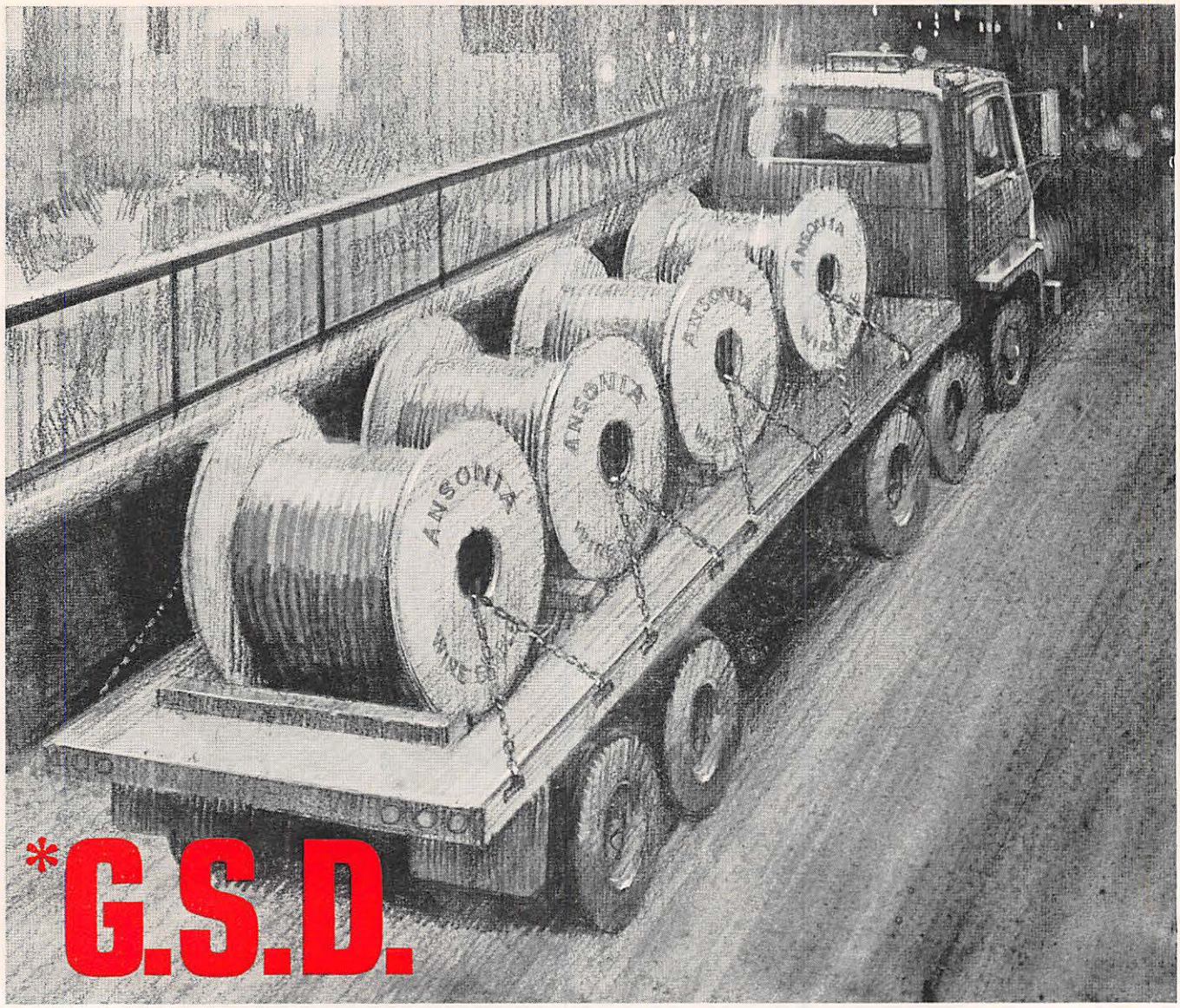

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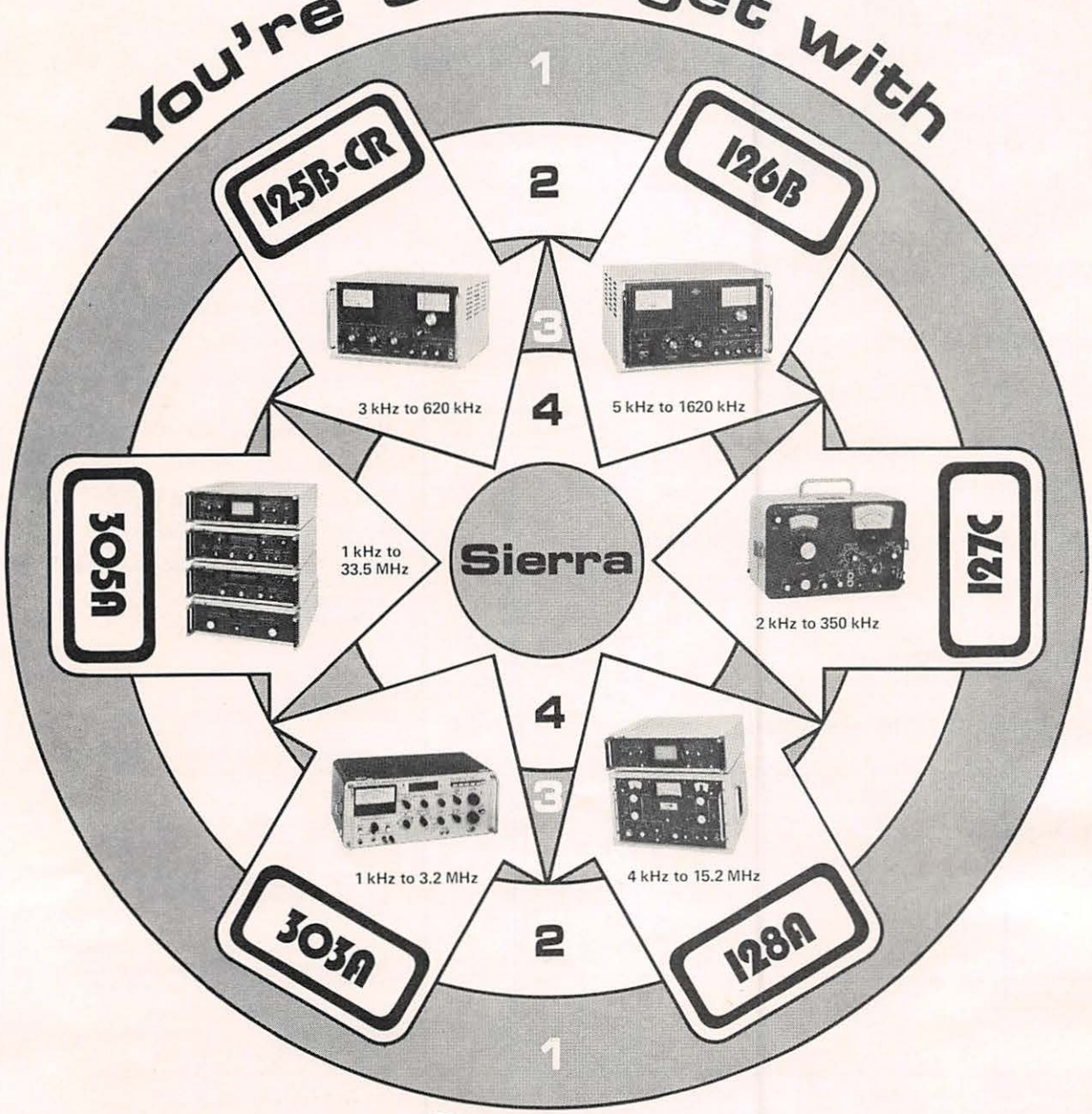

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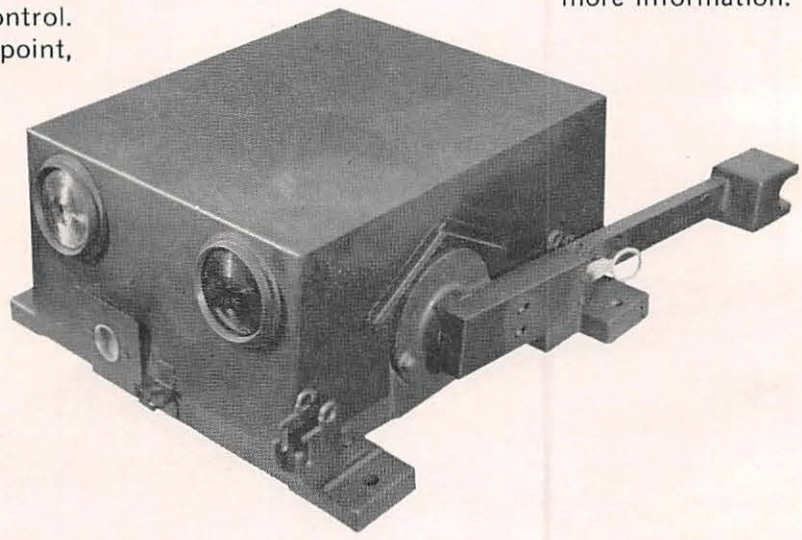

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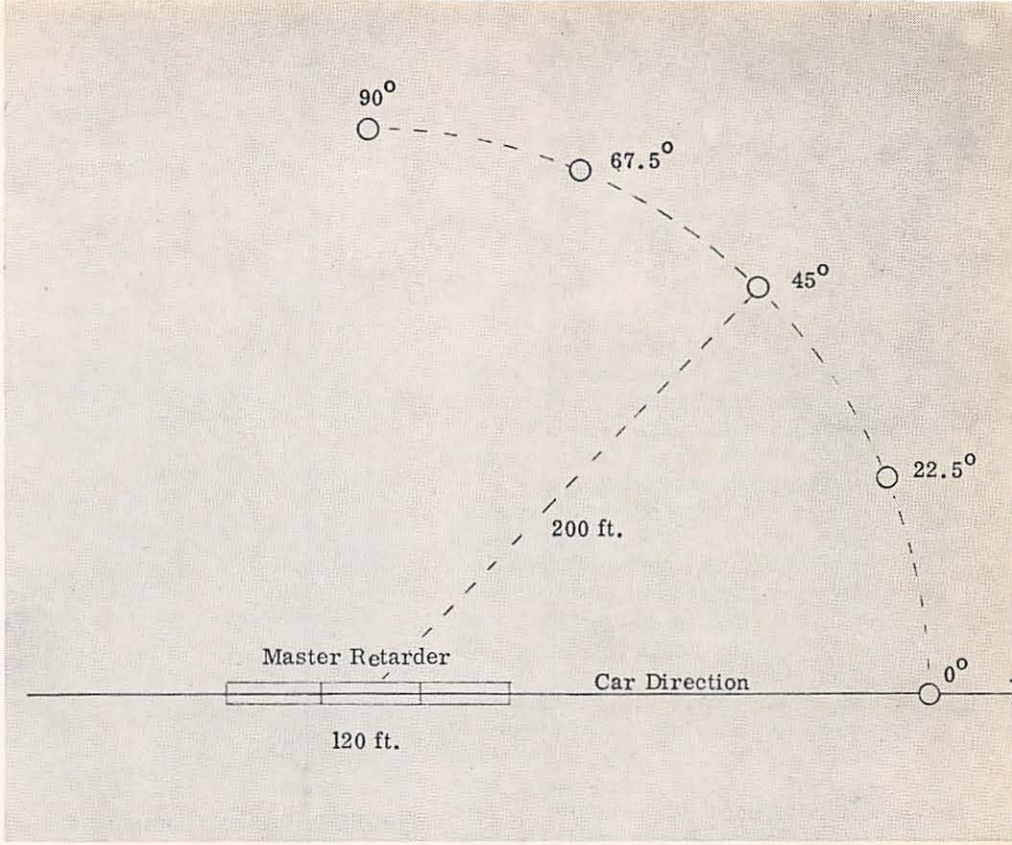


FIGURE 1: Locations of sound recording systems in relation to retarders.

Noise studied in retarder yards

Measurements made of noise created by cars moving through retarders in classification yards.

By HUGH C. KENDALL
Senior Consultant
Technical Marketing
General Railway Signal Co.

Retarder noise has long been accepted as a fact of life around railroad classification yards. This era however may be drawing to a close with the passage of recent legislation and the adoption of strict noise ordinances by public authorities in many parts of the country. Briefly stated, these noise ordinances may seriously restrict where new yards may be built in urban areas unless a dramatic reduction in the noise generated by retarders can be brought about.

The predominate noise associated with retarders is the familiar wheel screech which is frequently produced when the shoes of car retarders act on car wheels. These extremely loud and high pitched sounds often reach a level which is above the threshold of pain (120db) in the human ear in the vicinity of a retarder.

In August of 1969, quantitative sound level measurements were made on the five section GRS E-160 master retarder at Perlman Yard on the Penn Central. The intent of these measurements was to establish the maximum level of wheel screech which could be produced, and also the level of impact noise which is produced by car wheels as they move from one shoe beam to the next in the absence of wheel screech. For the wheel screech measurements, the first two sections of the retarder were opened, with the third, fourth and fifth sections set for maximum retardation (No. 4 position). A number of 70 to 100 ton covered cement hopper cars were humped singly into the retarder, entering the third section at from 12-14 mph, and coming to rest in the fifth section. Each car produced wheel screech which lasted for approximately five seconds.

Data on retarder impact noise was collected during normal humping operations on various types of cars which for one reason or another negotiated the master retarder without producing wheel screech.

Two sound recording systems were used. The first system was located at a position 90 deg to the track and 200 ft from the center of the fourth section of the retarder as shown in Figure 1. The second system was moved to cover various angular positions at a distance of 200 ft from the retarder. The recording microphones were approximately 4 ft above the ground and were pointed di-

MANAGEMENT INFORMATION

Interest in the abatement of retarder noise, principally wheel screech, is gaining momentum due to restrictive noise ordinances, which could prevent new yards from being built in urban areas unless retarder noise can be dramatically reduced. Wheel screech results from interaction between car wheels and retarder shoes. The sound level of wheel screech lies between 110 and 120 db at the retarder with principal frequency components in the 2-4,000 Hz band.

Reduction in sound levels may be obtained through the use of softer retarder shoe material, use of special lubricants, increasing the mass of the shoe beams or construction of acoustic barriers.

rectly toward the retarder. The two data recording systems are shown in Figure 2 together with the analysis system used to reduce the data into octave band sound pressure levels.

Figure 3 summarizes the measurements made at a distance of 200 ft from the retarder at an angle of 90 deg. It is interesting to note how consistent wheel screech is from car-to-car. The spread of the measured data for all cars falls within the relatively narrow shaded area in the figure. The overall peak sound levels range from 104db to 114db at 2200 Hz. These sound levels represent the maximum octave band levels sustained for a duration of one second. The maximum levels of a shorter time duration were found to be typically three to five decibels above levels sustained for one second. The dashed line toward the bottom of Figure 3 shows the maximum level of impact noise produced in the absence of wheel screech.

Sound level measurements made at various angles of incidence with respect to the retarder revealed that wheel screech in a horizontal plane is radiated in a relatively non-directional manner, except at a position on axis with the retarder (0°), where the level was found to be 5db to 10db lower at all frequencies. Subsequent measurements made in a vertical plane have revealed that the level of wheel screech falls off rapidly with increasing vertical angle.

The level and character of retarder noise as shown in Figure 3 is very typical of what may be found in any retarder yard. Wheel screech is produced by all present-day retarders regardless of manufacture.

Under line of sight conditions and in the absence of wind, it is valid to use the data measured at 200 ft from the retarder to extrapolate what sound pressure levels would have been measured at greater distances from the retarder. In this extrapolation, it is reasonable to expect that retarder noise would decrease with distance according to the inverse square law, and that the only other attenuation would be due to molecular absorption.

Figure 4 shows the estimated retarder noise level at a distance of 1,000 ft from the retarder, based on the 200 ft data. It will be seen that the maximum noise level due to wheel screech has been reduced by 19db at 2000 Hz,

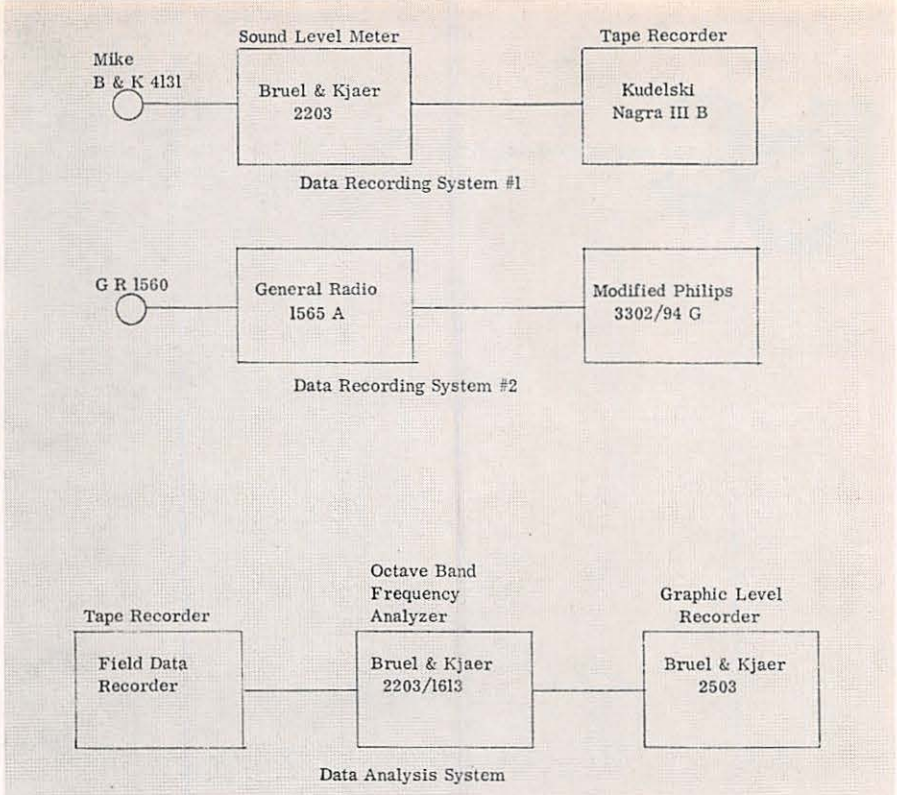
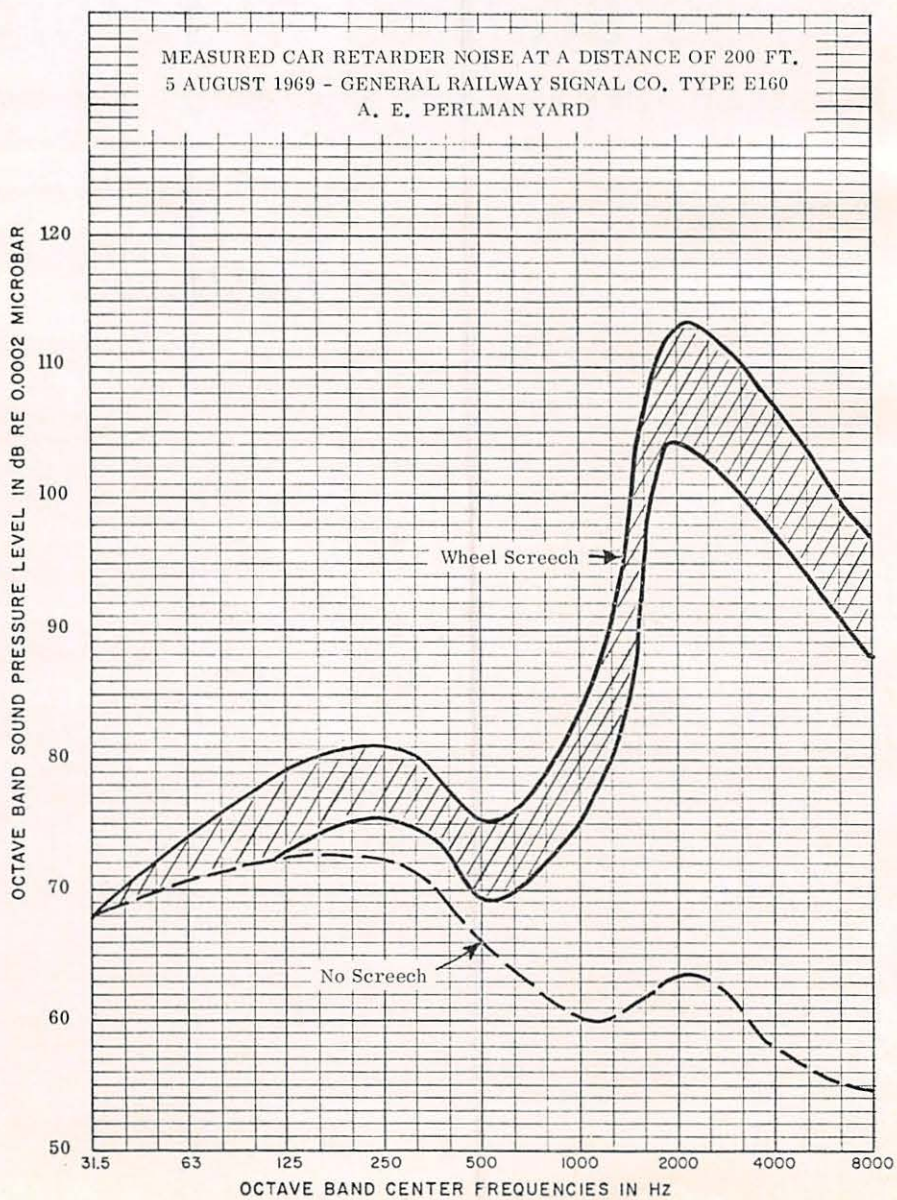


FIGURE 2: Two data recording and one data analysis system were used.



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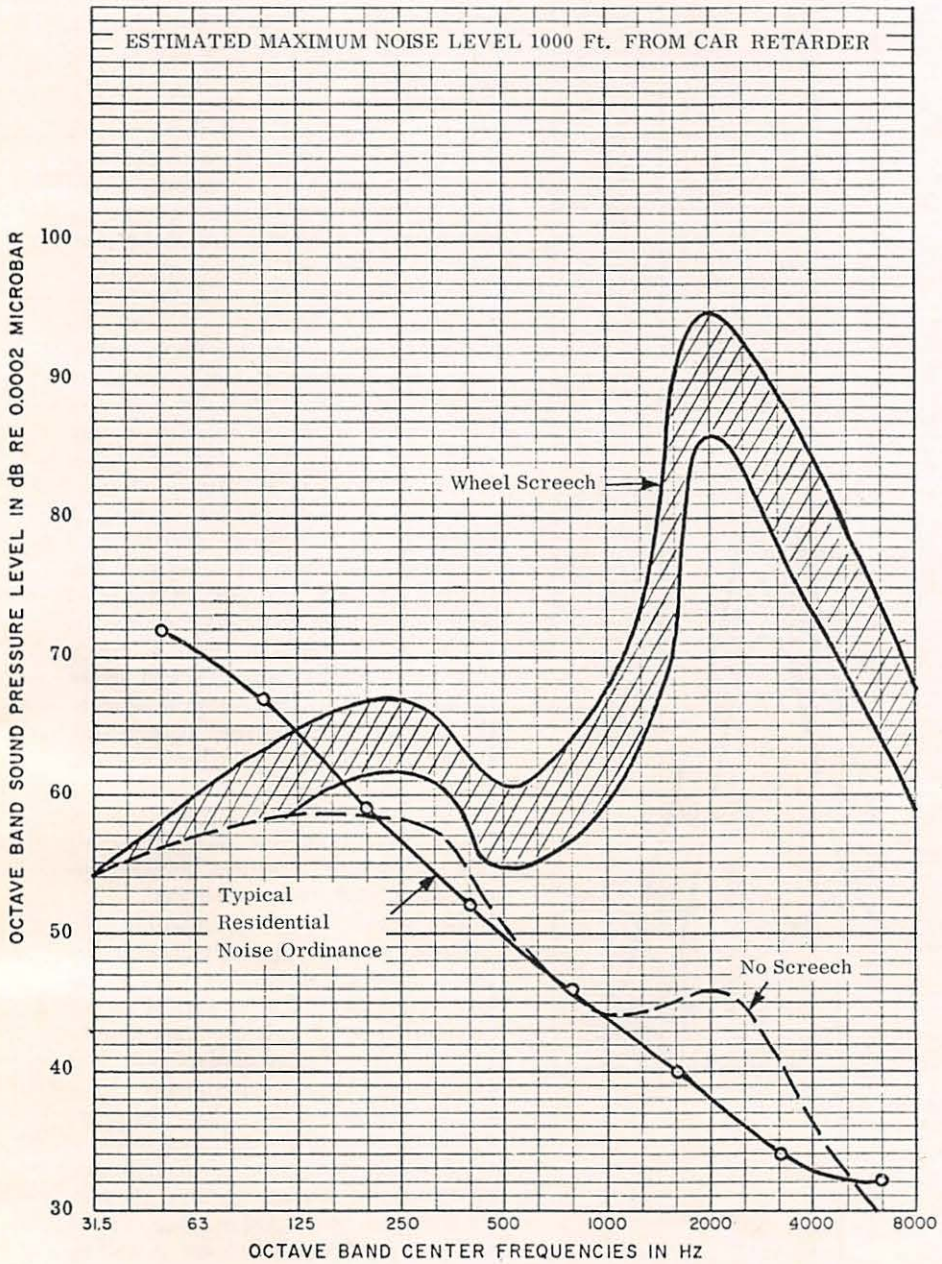

FIGURE 4: Estimated maximum noise level 1,000 ft from retarder.

SOUND LEVEL HIGHEST AT 2,000 HZ

FIGURE 3: Measured car retarder noise at 200 ft from retarder.

with the lower frequencies being attenuated somewhat less.

A curve representing the maximum sound pressure levels as a function of frequency which would be permitted at the property line under recently adopted typical residential noise ordinances has been drawn in Figure 4 to illustrate the magnitude of the problem. It will be noted, that the noise permitted under the ordinance falls off in level approximately 6db per octave, with only 38db permitted at 2,000 Hz. It is quite obvious that in the event wheel screech were allowed to occur within 1,000 ft of the property line, the noise ordinance illustrated would be exceeded by approximately 57db.

Figure 5 shows the 200 ft noise data extrapolated to 5,000 ft from the retarder. It can be seen that the maximum sound pressure level under wheel screech conditions has been reduced by 44db to a reasonably comfortable 70db, however, this level is still 32db above the ordinance.

Figure 6 shows the 200 ft noise data extrapolated to 10,000 ft from the retarder. At this distance, wheel screech would probably fit within the ordinance.

It may be concluded, that wheel screech cannot be allowed to occur in retarders which under line-of-sight conditions are located possibly as much as two miles from a residential area covered by such an ordinance. There are a number of retarder yards in the planning stage where such a separation between the yard and a residential community would be impractical to achieve. Retarder noise abatement, and in particular the elimination of wheel screech, has therefore become a pressing issue in the industry.

Car wheels are set into intense vibrations by action of the retarder shoes. The vibrations occur at frequencies which cannot be identified as being the natural resonant frequencies of either the wheels or the shoe beams, but rather a separate band of frequencies which is characteristic of the oscillating system composed of both the wheels and shoe beams in contact with each other. There is good reason to believe that the primary resonant part of the system is the wheel and not the retarder. The character of wheel screech strongly suggests that the phenomenon is produced by a stick-slip mechanism between the wheels and retarder shoes.

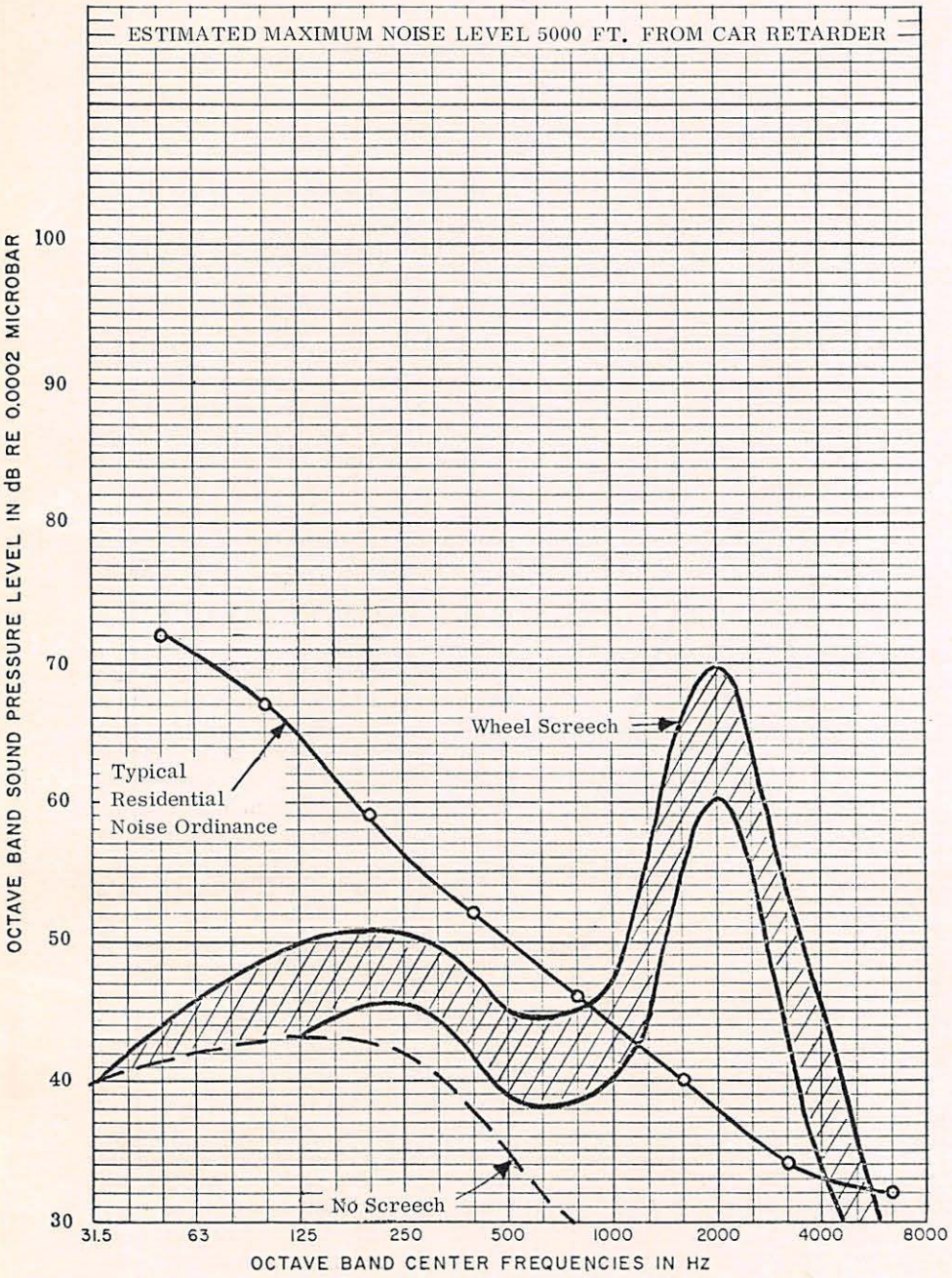

FIGURE 5: Estimated noise level 5,000 ft from retarder.

Stick-slip motion is associated with interface friction which is a decreasing function of sliding velocity. Relative motion of two sliding surfaces with appropriate effective masses and stiffness can lead to dynamic instabilities causing a build-up of intense vibrations in a direction perpendicular to the sliding surfaces at the natural frequency of the system. The intense vibrations which are imparted to a violin string by action of the bow is an example of stick-slip motion. The predominate component of the velocity of the rim of a car wheel with respect to a retarder shoe is perpendicular to the shoe, so that the wheel rim may indeed act much like a violin bow stroking the retarder shoe "string". The leverage or wedging action of the wheel as it forces the shoe beams apart enhances the stick-slip mechanism. It also causes a spragging motion to occur.

Spragging motion occurs, for example, when one tries to push a piece of chalk across a blackboard when the chalk makes a small angle with the normal to the board. This oscillatory motion does not depend on how the friction coefficient varies with sliding velocity, but it is a function of the geometry and force-vector directions in the contact area, and of the magnitude of the friction coefficient. Under appropriate conditions, the deformation of the components in the contact area cause alternate seizure and release of the sliding surfaces, again leading to dynamic instabilities and large amplitude vibrations perpendicular to the direction of relative motion of the two surfaces. The squeal which is sometimes produced in automotive disc brakes is caused primarily by spragging motion.

In any vibrating system, energy is dissipated as it oscillates, and the rate of energy dissipation increases with amplitude. If such a system is supplied with energy from an external source, its vibrations will build up until a steady state condition has been reached where the rate of energy dissipation is equal to the rate at which energy is supplied. It has been found that wheel screech, once it occurs, is almost always at a level of from 110 to 120db near the retarder, suggesting that it is the result of a steady state condition between energy input and energy dissipated.

The possibility of eliminating the stick-slip and/or spragging motion between retarder shoes and wheels has been the subject of a number of recent investigations. Various experiments have been conducted under controlled conditions. These experiments have sought to eliminate or reduce the energy input responsible for the action by:

Changing the nature of the retarder shoe material—Various grades of ductile iron have been tried in place of steel as shoe material in both inert as well as active retarders. These trials have established the fact that wheel screech rarely, if ever, occurs in a ductile iron equipped retarder at car speeds under six miles an hour. At car speeds above this however, wheel screech can be produced, and when it is produced its sound level is approximately the same as that produced using steel shoes. At the higher car speeds, the principal effect of ductile iron shoes appears to be a significant reduction in the *number* of cars which produce wheel screech as compared to the use of steel shoes. Us-

ing ASTM 60 ductile iron shoes, a reduction of ten to one in the number of cars producing wheel screech has been achieved in a group retarder. In this particular retarder, the following also has been observed:

(a) Under constant retarder pressure, greater wheel travel in the retarder is required to produce wheel screech than with steel shoes.

(b) Shoe wear at the same retarder pressure appears to be approximately four times as fast as with steel shoes.

(c) Retarder rating is improved by 12% to 15% over that possible using steel shoes.

Changing the mass and stiffness characteristics of the shoe beams so as to shift resonances out of the frequency region of excitation—Limited experiments along these lines have shown that increasing the mass of the shoe beams has a negligible effect on the production of wheel screech. Experiments involving changing the stiffness of shoe beams remain to be conducted.

The use of retarder pressure modulations to interrupt the input energy to the wheel screech mechanism on a cyclical basis—As a general observation, retarders under atuomatic control produce wheel screech less frequently than under manual control. The reason for this is believed to be related to the length of time required for wheel screech to build up. Under automatic control, the retarder is opened and closed in a cyclical manner to maintain a car within close tolerance of the desired speed. The cycle time is frequently shorter than the wheel screech buildup time. Under manual control, the retarder is usually closed for longer periods of time, which intervals exceed the wheel screech buildup time.

The use of car wheel damping in the retarder—Preliminary experiments along these lines have proven to be ineffective in eliminating wheel screech.

The use of lubricants to lower the stick-slip ratio between the retarder shoes and the wheels—Certain lubricants have a stick-slip ratio less than unity, and have a profound effect on retarder noise. Wheel screech can be totally eliminated by using the proper amount of these lubricants. The price one pays for the use of a lubricant on the shoes of a retarder is loss of retarder rating. Experiments have recently been conducted with various lubricants to determine the rating lost in a retarder by the application of the minimum amount of lubricant required to prevent stick-slip action, and therefore wheel screech from occurring over a full range of pressures. Preliminary results from these experiments indicate that it might be possible to retain more than 75% of the original rating. Much more needs to be done however under a wide variety of conditions before the full impact of controlled lubrication can be evaluated.

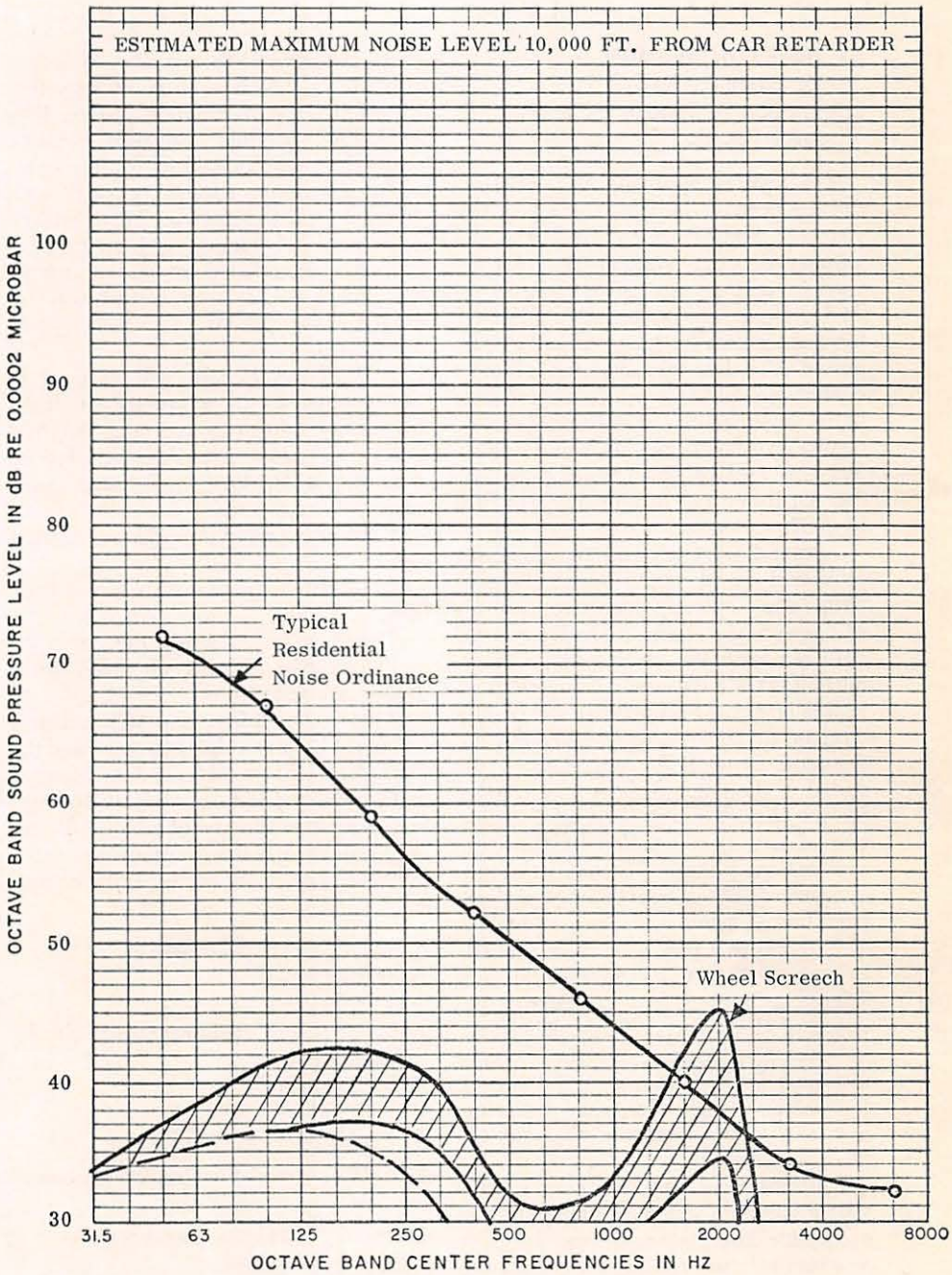

FIGURE 6: Estimated maximum noise level 10,000 ft from retarder.

Acoustic Barriers—It should also be borne in mind that means are at hand for attenuating the propagation of wheel screech through the use of suitably designed acoustic barriers running parallel to the retarder up to a height of 10 ft. Since wheel screech is propagated horizontally and at right angles to the direction of movement of the car, various forms of masonry walls could be expected to produce a shielding effect of 20db or more. Little has been done in evaluating masonry barriers.

Knowledge of ACI helpful to

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The task of applying ACI labels to the car fleet of the U.S. and Canada is virtually completed. Over 100 ACI scanner/decoder systems are now in service, and a substantial number of ACI systems are on order or planned. Several railroads have already integrated ACI data into an information or control system. ACI can be expected to figure significantly in information and control systems from this time forward. Systems and programming personnel can hardly expect to remain untouched by ACI.

Although systems and programming personnel need not become familiar with the optical/electronic aspects of scanning and decoding ACI data nor with the electronics of transmitting ACI data, some knowledge of ACI is essential for optimum use of ACI data in an information system. An understanding of how ACI data is encoded in the label, of how it is handled by the decoder and optional features, and of how it is handled by the communications system will enable the programmer to obtain maximum usefulness from the ACI data.

External to a processor or central data system, the ACI data can be considered as coming from a system composed of three parts: (1) the labels, (2) the scanner/decoder, (3) the communications links. Optional ACI features, located at the decoder, can store, format, and convert data to alpha, and add header messages.

Automatic car identification can provide a valuable source of timely data to an on-line information system. In order to effectively use ACI, it is necessary to understand what data it can provide, and in what format it will supply the data. ACI can supply certain basic information, and, at the user's option, certain supplementary information.

Basic information includes reporting marks and position in train for every unit of rolling stock.

Supplementary information includes: date, time, direction, and route of movement; reporting marks and position in train for labeled trailers and for labeled containers; secondary information from secondary labels and variable information from variable labels.

Significant about ACI data entered into an information system is the fact that the ACI data generally will not initiate the record; that is, the ACI data will not be the first entry of reporting marks into the information system. Bills of lading, waybills, advance consists, and other sources will likely have provided the system (central or local) with the first report of any car. There will be exceptions, of course, such as cars received in interchange or cars on a train for which no advance consist was received, where the ACI data will initiate the record.

ACI data will generally be used to perform an audit or verification function in an information system. An ACI list for a train can enable an information system to do several things, such as:

Correct reporting marks in a train file.

Correct the location of cars in a train file.

Detect no-bill cars in a train.

Detect the omission of cars from a train (overbills).

This audit ability that ACI can provide will be particularly useful since the ACI data will be independent of manually reported data already in the system. ACI can thus be of significant value in improving the accuracy and reliability of data in the information system. The ACI data will be timely in that it will generally be entered into the system almost immediately after the scan of the train has been completed.

Fundamental to using ACI data is an understanding of the ACI label format. An ACI label consists of thirteen modules, each of which represents a decimal digit, or a special character. The character set includes Start, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, Stop and 10°. (Written 10° and called 'Ten-Star'. It is a one module representation of a two digit number, 10. It can appear only as the check digit module.) The ACI system interprets the special characters, and has an output character set of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, and ?. Scanning of an ACI label is vertical, starting from the bottom of the label and moving upward. Reading from the bottom, the first module is Start. Next is a 4-digit index code of which the first or lowest digit is the equipment code and the next three digits are the owner code. Next in order is the 6-digit car number (zeros precede any fewer than 6 digits). Immediately above the car number is the Stop module, and at the very top is the validity check digit.

The output of a basic ACI system for such a label can take two forms: nnnn

```
9494 101112-0 (locomotive)
0351 061553-6
1503 000451-7
0822 089729?8 (validity fails to check)
1588 473467-4
0022 301319-5
0494 721007-6
8494 013905-5 (caboose)
```

FIGURE 1: Output from basic ACI system.

```
9MP    101112-0 (locomotive)
 IC    061553-6
 RMDX  000451-7
 0822  089729?8 (validity fails to check)
 TTX   473467-4
 ATSF  301319-5
 MP    721007-6
8MP    013905-5 (caboose)
```

FIGURE 2: Output from basic system with carrier index.

```
9494 101112-0
0351 061553-6
1503 000451-7
0822 089729?8
1588 473467-4   2271 202338-5   2337 709191-1
0022 301319-5
0494 721007-6
8494 013905-5
```

FIGURE 3: Output from basic system with format control.

systems analysts, programmers

nnnnnn-n when validity checks and nnnn nnnnnn?n when validity fails to check. When 10* appears as the validity check digit, the - appears in the output; nnnn nnnnnn-- when validity checks, and nnnn nnnnnn?- when validity fails to check.

The first steps in programming for ACI are to determine (1) what information will be entered; and (2) what is to be done with the information.

What information is to be entered will depend on which options are acquired with the basic ACI system. To understand the effect of some of the available options, it is first necessary to understand the usefulness of the equipment code digit in the ACI label. Equipment codes have been assigned as follows: 0 and 1 are for railroad and private freight cars; 2 is for trailers; 3 is for trailer expansion; 4 is for containers; 5 is for container expansion/secondary labels/variable labels; 6 is for work cars; 7 is for passenger cars; 8 is for cabooses; and 9 is for locomotives. Note that equipment codes 2, 3, 4, and 5 denote "non-rail" labels in the sense that they do not identify a unit of rail rolling stock.

The Basic ACI system outputs, on a real-time basis, a list of the rail labels in the train. The output character set includes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, and ? Output is restricted to labels for which the equipment code is 0, 1, 6, 7, 8, or 9. (There is no output for labels for which the equipment code is 2, 3, 4, or 5.) An example of output from a basic ACI system would be: (See Fig. 1).
The comments in parentheses are *not* part of the output.

The optional carrier index converts the four digit index code to the initials of the equipment owner. There are some exceptions. The carrier index will not convert: (1) codes 5800 through 5899 (the secondary label codes); (2) codes 5900 through 5999 (the variable label codes); and (3) any code for which validity fails to check (? instead of -). Some of the early production carrier index units were produced without the ability to convert index codes beginning with 2, 3, 5, or 5. The carrier index cannot convert any code that has not been programmed into it. Periodic up-dating is required to allow for new codes that have been assigned.

An example of the output of a Basic ACI System with Carrier Index option would be: (See Fig. 2).

Note the digit nine preceding MP for the locomotive and the digit eight preceding MP for the caboose. A feature of the carrier index output is the output of the equipment code digit when it is 6, 7, 8, or 9. This digit serves to immediately identify the unit as something other than a revenue freight car.

The format control-storage register option permits the ACI system to output labels with equipment codes 2, 3, 4, or 5, in addition to basic system ability to output labels with equipment codes 0, 1, 6, 7, 8, or 9. The format control option causes the output of any label with equipment code 2, 3, 4, or 5 to appear on the same line and to the right of corresponding basic output. Trailers, for example, will appear to the right of the flat car on which they are loaded. An example of the output of a basic ACI system with format control would be: (See Fig. 3).
The two numbers to the right of the flat car number are trailer numbers. The format control option is sometimes referred to as piggyback format.

The message generator option permits the ACI system to transmit up to 64 alphanumeric characters as a message prefix or/and suffix. Both fixed and variable data may be transmitted. Fixed data typically includes: prefix code number; scanner number; scanner location information; suffix code number; and end of message indicator. Variable information can include up to four inputs: message sequence number (001 through 999); date (001 through 366); time (2401 through 2400); and train direction. The fixed data can change from one scanner to another, but it is fixed for any given scanner.

The core buffer option permits the basic ACI system to store the label data at any train speed up to 80 mph. After the train has passed, the ACI system then transmits the data at whatever speed is desired. Two sizes of core buffer are available: 500 label size and 1,000 label size. Use of the core buffer requires use of the generating option.

The calendar clock option permits in-

Type	Code	Response	Words/min
AAR	8-level ASCII	Polled	Specified by customer
"	5-level Baudot	Polled	Specified by customer
	5-level Baudot	Demand	60, 75, 100
83B2/3	5-level Baudot	Polled	
IBM 1050	7-level	Polled	
	8-level ASCII	Demand	100, 150
85A	8-level ASCII	Polled	100, 150

STANDARD INTERFACES connect ACI to communications circuits.

The validity check calculation is based on multiplication by ascending powers of two, addition, and division by eleven. The mathematics of the validity check calculation are best illustrated by an example:

Car: MP 87620 Index Code–0494

Powers of Two	Validity Check Calculation	
	3	check digit
	Stop	
2^9–512	0	× 512 = 0
2^8–256	2	× 256 = 512
2^7–128	6	× 128 = 768
2^6– 64	7	× 64 = 448
2^5– 32	8	× 32 = 256
2^4– 16	0	× 16 = 0
2^3– 8	4	× 8 = 32
2^2– 4	9	× 4 = 36
2^1– 2	4	× 2 = 8
2^0– 1	0	× 1 = 0
	Start	Sum 2060

The sum, 2060, is divided by eleven: $\frac{2060}{11} = 187$ and $3/11$
The remainder, 3, is the validity check digit.

VALIDITY CHECK CALCULATION based on the powers of two.

sertion of the date and time into the message prefix (or suffix). The time is the time at which the train's approach turned on the scanner. The date provided is the Julian calendar date, 001 through 366 days. The time is provided in 2400 hour format.

There are some other optional features available, but they are not of direct concern to the programmer. One option that has just been announced is of importance to the programmer. A different kind of format control is now available. It differs from the previous format control in two ways: (1) there is no limit to the number of trailer, container, secondary, or variable data labels it can output;* and (2) the rail car label is output last, after the other labels.

*The number of labels that can appear on any one car and its lading is limited by the labeling rules. A total of nine labels would seem to be a practical upper limit. (One rail label and eight non-rail labels).

This new option is identified as format control—dual register option to distinguish it from the previous (and still available) format control—storage register option which could output only two other labels per car in addition to the rail car label. All labels are output in column sequence, there is no offset to the right for any label output.

It is possible that some ACI data will be entered into the computer of an information system by punched card deck or by paper tape. However, the great bulk of the ACI data can be expected to be entered to by a telecommunications link. ACI manufacturers have developed both standard and special communication interfaces for use with ACI.

There are several basic processing steps to be taken with ACI data that will be performed in most systems using ACI data:

- Since most train consists are in the order of caboose first, but ACI data is in the order of passing the scanner, which will usually be locomotives first, the first step is to reverse the order of the ACI data, if required.
- Search the ACI data for any unusual data output, such as repeated data due to trains doubling or to switching moves by a scanner.
- The next step will be to compare the ACI data with the previous consist, if any, in the files. This process will:

—Verify the presence and location of cars in the train.

—Identify cars in the train that were not expected to be in the train (no-bill cars).

—Indicate the absence of cars that were expected to be in the train (overbills).

—Identify cars with un-readable labels, or bad labels or incorrect ACI outputs.

—Reconstruct correct identification where possible by using the ACI validity check digit and verifying by previous information.

Up-date all appropriate files, and transmit to appropriate points any verified consists required.

The validity check digit and the validity indication are useful for two purposes:

(1) An indication of the reliability of the reported car data.

(2) Reconstruction of a correct car initial and number as part of data enhancement.

When a car label is prepared, the validity check digit is calculated, usually by means of a nomographic form, and the proper validity check module is applied.

When a label is scanned, the ACI system reads the index code and the car number, and calculates the validity check digit internally. The ACI system also reads the validity check module on the label. It then compares the internally calculated check digit with the read

OUTPUT FROM ACI WITH INDEX, FORMAT CONTROL, CLOCK, MSG GEN

ACI Output					Comments
5 004	DUPO SOUTH EAST N BND 007 231 1550				Prefix Message
?MP	100626-9				locomotive
9TP	100600-6				locomotive
CNW	003079-3				
NP	006725-2				
GATX	010213-5				
DOWX	004127—				
TP	251509-9				
LTTX	500594—	2389	700129-5		one labeled trailer
0000	00000000	2389	707487-7	2389 704187-3	unlabeled car, two labeled trailers
TTX	650900-8	2341	700169-3		one labeled trailer
RTTX	501391-0				
DUPX	029735-2				eight axle car, two labels per side
DUPX	029735-2				(same data appears twice)
0541	181504?6				validity did not check, will not convert
PRR	112544-3				
CBQ	062813-6				
GACX	043564-3				
0000	00000000				unlabeled car (could be unreadable label)
1804	006070-3				not convert, code not in Carrier Index yet
ACFX	054671-8				
0000	00000000	4009	203724-5		unlabeled car, one labeled container
BO	354778-8				
6MP	008050-4				work equipment
6MP	008041-7				" "
6494	008005?7				" " , validity not check, will not convert
6MP	008045-9				" "
6MP	008043-8				" "
8MP	013486-0				caboose
5	END#				Suffix Message

The prefix message (header) provides the following information:
Scanner Number 004, at Dupo, South of the yard, on the East main track
Northbound Movement
Message Sequence Number 007
Day 231 (August 19)
Time 1550 (3:50pm)

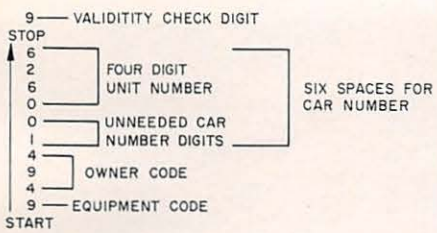
check digit. If the two validity check digits are the same, a - is output; if they are different, a ? is output.

Reconstruction of correct car data involves determining a potentially correct car initial and number from an independent source and verification by the check digit calculation. As an example:

ACI Car Data
0494 770934?3
Waybill Data
MP 770934

The car data from ACI matches that from the waybill file. A check digit calculation based on the waybill data yields a check digit of two. It is likely that the label has the wrong check digit module.

Locomotives use the same basic label as other rail equipment. The equipment code nine denotes a locomotive. However, the label has space for a six digit car number, while most locomotives use either a three or four digit number. The two unneeded car number digits are used to convey additional information about the locomotive. (Note: for multiple unit diesel power, each unit has a label.)



The first unneeded car digit (lower on label) is used to identify the type of unit according to the following code:

1 is for control or lead unit
2 is for booster or "B" unit
3 is for relay or slave unit
4 is for engineer side of control unit
5 is for other side of control unit
6 is for right side of slave unit
7 is for left side of slave unit
8 is for unit with dual control stands
9 is reserved for future assignment

The second unneeded car digit (upper on label) is used to identify a unit that has an alphabetical suffix as part of its number according to the following code:

0 is for no suffix
1 is for letter A
2 is for letter B
3 is for letter C
4 is for letter D or L

The digits that identify the side of a locomotive (4 or 5 in first unneeded position) can determine the direction in which a unit is headed provided train direction and scanner location (which side of the track) are known.

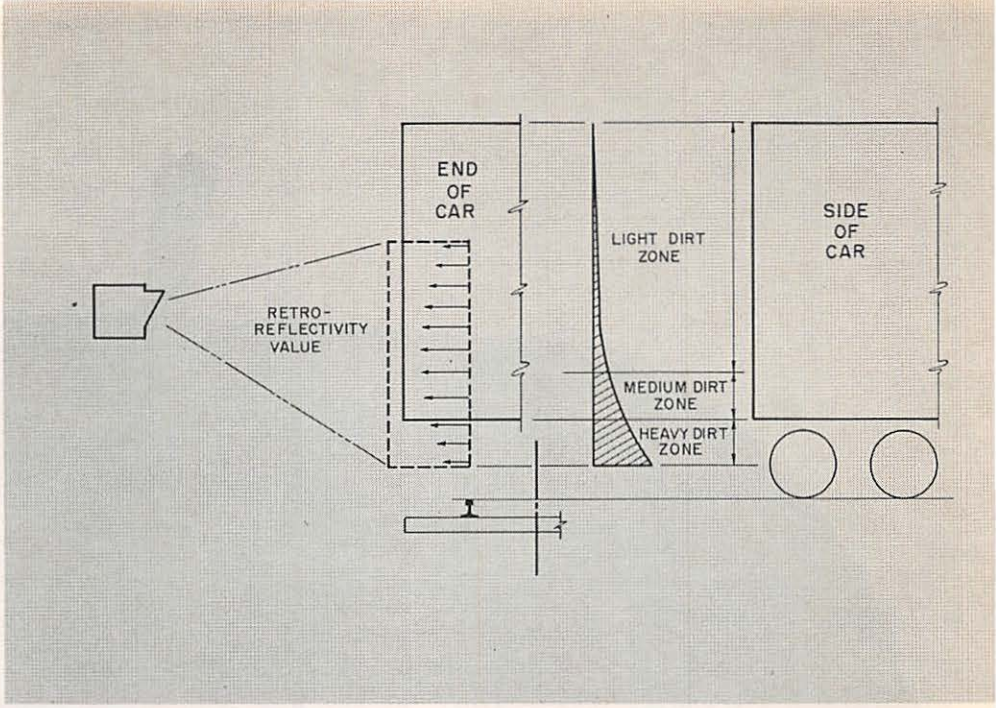


FIGURE 1: Effect of label height on readability.

Label is information source for ACI system

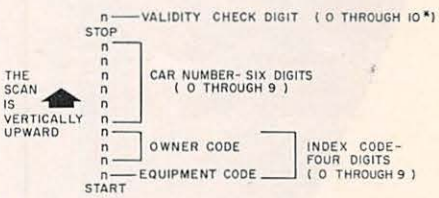
By JAMES H. SEAMON

The ACI label is the prime information source for the ACI system. For the ACI system to be of maximum usefulness and reliability, three requirements must be met by labels:

Every unit of rolling stock must be labeled.
The information in the label must be correct.
Readability of the label must be maintained.

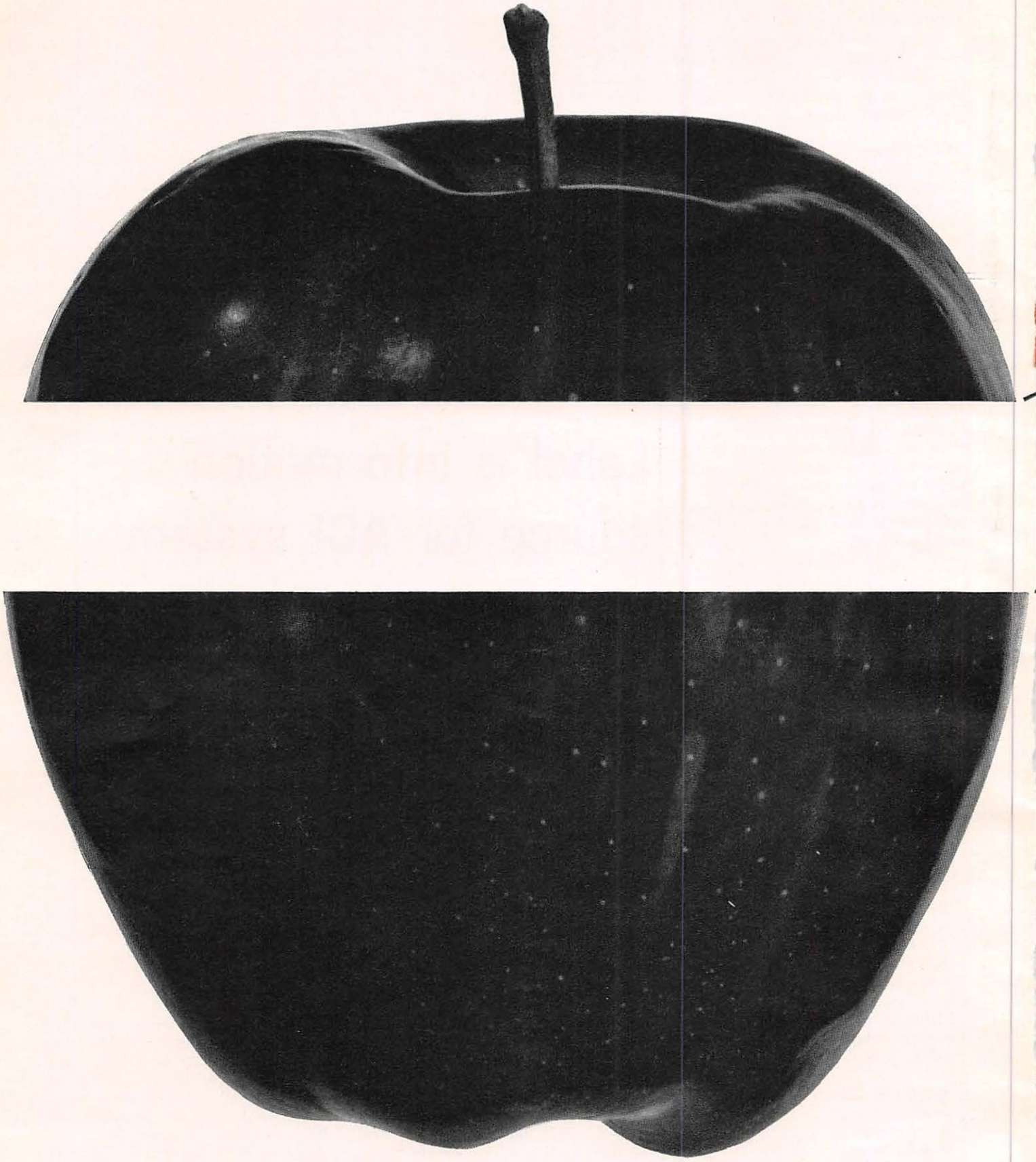
Four concepts are critical to good label application: (1) correct information must be encoded in the label; (2) the scanner optical system must be able to "see" the label; (3) car count logic requires proper horizontal label placement; (4) proper application and optimum location are essential for maximum label life.

An ACI label consists of thirteen individual modules arranged in a prescribed format. When one looks at a label, modules are arranged in the following order, starting from the bottom and working upward: The lowest module is the Start module. The next four modules are the index code consisting of four digits. In this grouping of four, the lowest is the equipment code and the next three are the owner code. Above this group of modules are six digits representing the car number. Above the car number is the Stop module and above this at the very top of the ACI label is the validity check digit. The index code and car number are permitted digits 0 through 9. The validity check digit is permitted digits 0 through 10°. If the check digit is 10, it is written 10° and called "Ten Star". It is a one-module representation of a two-digit number 10.


n — VALIDITY CHECK DIGIT (0 THROUGH 10*)
STOP
THE SCAN IS VERTICALLY UPWARD
CAR NUMBER- SIX DIGITS (0 THROUGH 9)
OWNER CODE
INDEX CODE- FOUR DIGITS (0 THROUGH 9)
n — EQUIPMENT CODE
START

To provide correct information, it is necessary to: use the correct equipment code number; look up the proper owner code based on the initials; get the car number correct; calculate the correct validity check digit; and be certain the label is placed on the correct car.

Selection of the location for the label involves three considerations: (1) the scanner must "see" the label; (2) the label must be protected from damage and dirt to maintain its ability to reflect the light back to the scanner; (3) car count logic requires controlled horizontal placement of the label.



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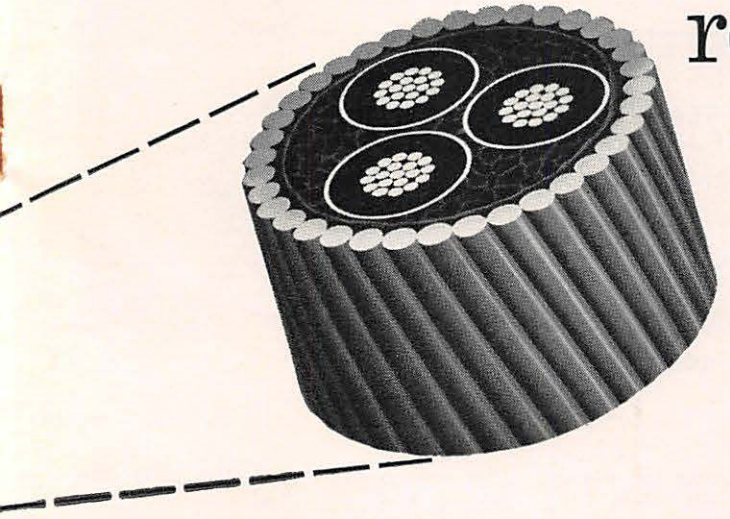

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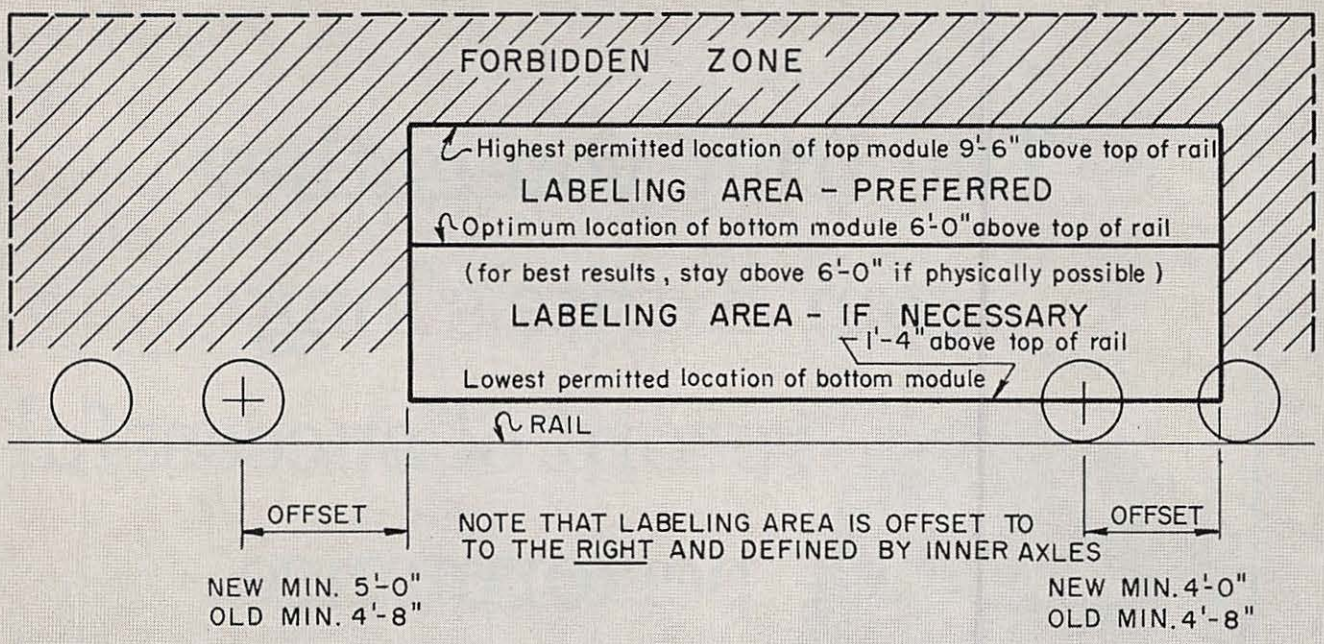

FORBIDDEN ZONE
Highest permitted location of top module 9'-6" above top of rail
LABELING AREA - PREFERRED
Optimum location of bottom module 6'-0" above top of rail
(for best results, stay above 6'-0" if physically possible)
LABELING AREA - IF NECESSARY
1'-4" above top of rail
Lowest permitted location of bottom module
RAIL
OFFSET
NOTE THAT LABELING AREA IS OFFSET TO TO THE RIGHT AND DEFINED BY INNER AXLES
OFFSET
NEW MIN. 5'-0"
OLD MIN. 4'-8"
NEW MIN. 4'-0"
OLD MIN. 4'-8"

FIG. 2: PREFERRED LABELING AREA is between 6 ft and 9 ft 6 in. above top rail.

Because of the optical factors in both the label modules and in the scanner, it is easier to read a label at mid-height than it is to read a label at the high or low limits of scan. Because of the effect of dirt on the label it is better to place the label in as clean an area as possible.

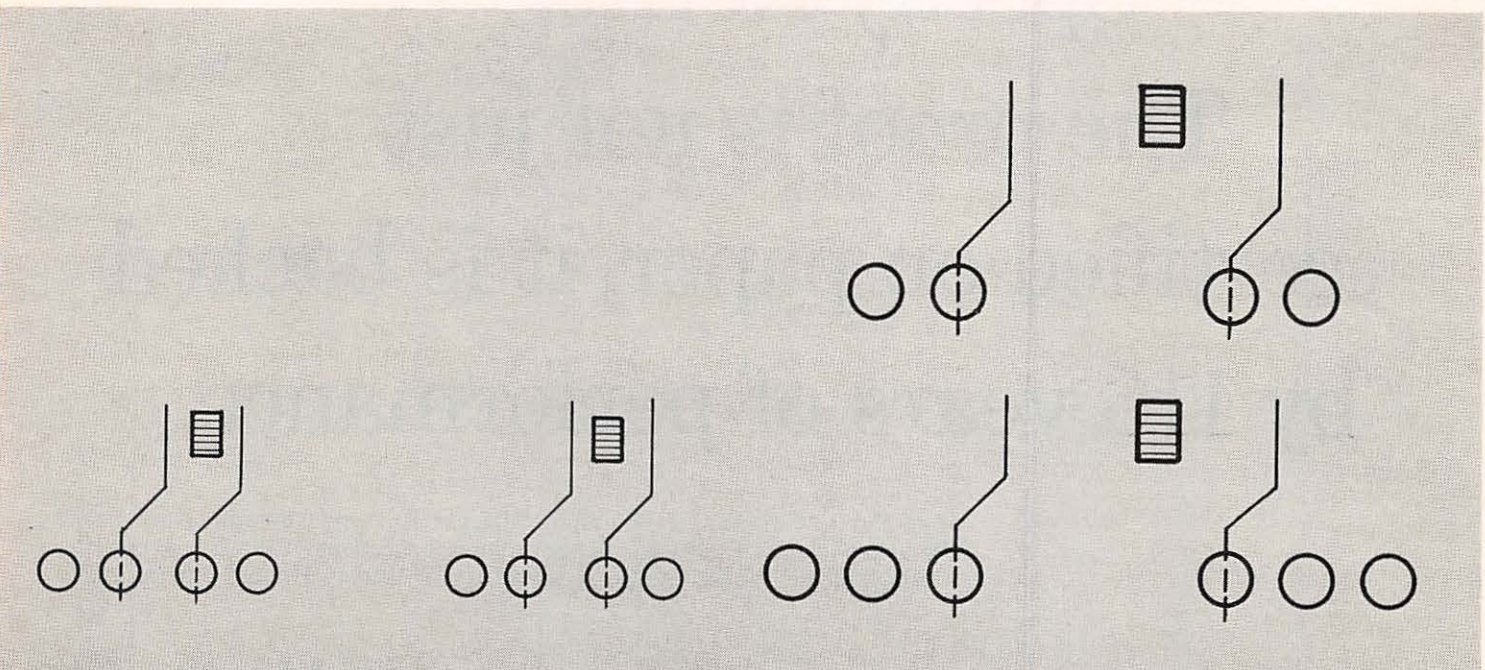
Generally, the lower the location, the dirtier the area. Certain specific areas, under loading hatches, over the wheels, etc. tend to be unusually dirty. The combination of optical factors and dirt factors has resulted in a general rule:

—Whenever possible, the bottom of the label should be 6 ft above the top of rail.

—When it is not possible to place the label this high due to physical factors (flat car, gondola car, etc.) place the label as high as possible.

—Avoid placing the label in an unusually dirty area, or under commodity loading hatches, or over the wheels of tank cars.

—If necessary to place the label under an overhang, such as under the deck of a flat car, be certain the top-



LABELS ARE OFFSET TO THE RIGHT of innermost axles of 4 and 6-axle cars; 8-axle car is treated as two cars of 4 axles each; 12-axle car is treated as if it were two 6-axle cars.

most module of the label is visible to the scanner.

There are other considerations involved in the location and application of labels:

—The placement of the label should be plumb. Tilt to either the right or left must be avoided.

—The label surface should be vertical. Tilt forward or backward should be avoided. Tilting the bottom of a low label backward is particularly bad, because it tilts the label away from the scanner.

—Curved side cars present a particular problem. For cars with gently curved sides (large diameter tank cars and large covered hoppers) the label may be placed on the curved surface. However, it should be placed such that the center of the label will be nearly vertical, so that neither the top nor the bottom of the label is curved excessively away from the vertical. Cars with sharply curved sides must be labeled by using a bracket to support a flat vertical plate.

Certain types of cars in certain commodity service seem to be thoroughly covered by commodity spillage. For cars subjected to this problem, a small shield can be placed above the label to deflect spillage. The shield must not be so deep that it obscures part of the label.

Figure 1 illustrates the effect of label height on readability. As indicated by the length of the arrows, the greatest light return is at mid-scan height. Also shown is the general relationship of label height to dirt intensity.

The combination of the two factors—light return and dirt intensity—led to the recommended location of 6 ft above top of rail for the bottom of the label when ever possible. Six feet above top of rail is just above mid-scan height.

One other factor must be considered when locating labels on open top equipment, particularly hopper cars. The factor is flame thawing of frozen loads. Some hopper cars have had labels applied low on the car and over the discharge doors. Such labels will almost certainly be destroyed by flame thawing. AAR label application rules recognize the flame thawing problem and recommend location of the label high on the car and to the right of all discharge doors.

The ACI System uses a wheel detector and counting circuits to help perform two functions: (1) detection of unlabeled cars (and of cars with unreadable labels); (2) location of labeled trailers and labeled containers on the correct flat car. Because of the relationship of the ACI label to the wheel count, the horizontal location of the label (along the car) is important.

The basic reference points are the innermost axles of the car. However, to accomodate labeling of double-door, 40 ft boxcars, the labeling area has been *offset to the right* of the basic reference points. This offset was accomplished by an offset location of the wheel detector to the left of the scanner light beam. It is important that this offset be observed when labeling cars.

Note that the offset is *always to the right*, as one faces the side of the car, regardless of which side of the car is being labeled.

The dimensions associated with the offset are shown in Figure 2. The exact offset dimension is 4′-8″, but the 5′-0″ and 4′-0″ are used to provide an allowance at limit of labeling area.

When selecting the location for an ACI label, take a good look at the proposed location before applying the label. If the location is excessively dirty, or if the car body shows signs of damage, it is not a good location for an ACI label, and a better location should be found if possible. When selection of label location involves a new car, observation of labels on existing cars of that type can provide an indication of good and poor label locations.

Label economy requires optimum readability and maximum label life. Optimum location on the car and proper application to the car help to assure maximum label life. Proper application can be obtained by following the application rules in the AAR "Instructions for Automatic Car Identification Permanent Label Application". This publication has been revised several times by the AAR, and the latest revision should always be used. Particular care should be given to surface preparation, module application, and edge sealing.

After a label has been placed on a car, and after all painting and edge sealing is complete, a final check of the label should be made. Compare the label to the car number, check the label format, check its location, and be sure the pre-mask tape has been removed from the modules.

MP HAS LABEL INSPECTION RULES

Missouri Pacific has issued instructions to its car department forces concerning ACI label inspection practices.

Suggested Procedures for Routine Inspection of ACI Labels—

When a car is at a repair track or other mechanical facility, careful inspection should be made of the ACI label.

Location: Is label within permitted area for car type? Horizontal? Vertical?

Information: Check the equipment code. Check the road code (from dictionary on 9127 form). Check the car number. Calculate the check digit (use Quik Trak form). Are Start and Stop in proper location?

Condition: Has label been damaged? Is label dirty? If so, wash according to prescribed rules. Is label faded? Are edges of modules peeling?

Notes: (1) If one or more modules are replaced, the remainder of the label should be washed to present a uniform label. (2) If necessary to replace a label, consider carefully the location. The label should not only be within the permitted area, but should be placed in the best possible location from the viewpoints of readability and of protection. Also, the location rules have been revised and replacement labels must conform to the new rules.

Washing Rules: (for temperatures above 32°F)—

(1) Flush label with clean water.

(2) Carefully wash with mild detergent. Avoid vigorous rubbing.

(3) Rinse label with clean water.

(4) If tar, oil, etc. cannot be removed by washing, use kerosene, mineral spirits, or V.M.&P. Naptha. (These solvents are flammable. The AAR Research Laboratory has been requested to identify useful non-flammable solvents. When identified, non-flammable solvents will be specified.) Avoid excessive scrubbing. Follow such cleaning with a water wash and rinse.

(5) Detergent or cleaning agent used must be a wet, non-abrasive type. It must not be strong acid, nor strong alkaline, and must be free of strong aromatic content, and must be free of chlorinated solvent.

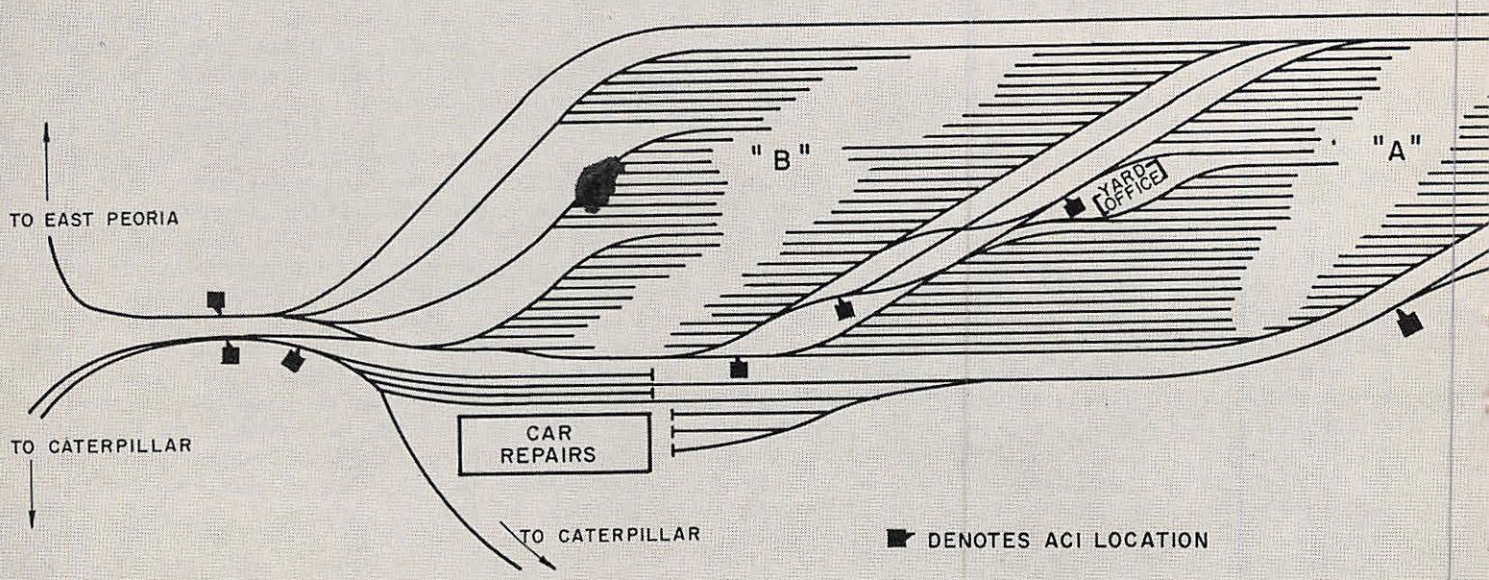
Label Repair—

(1) First, clean the label as outlined in the washing rules.

(2) Incorrect module—apply correct module directly over incorrect module. Do not use primer-activator.

(3) Damaged or out of place modules—remove module with sanding disc or scraping tool. Prepare surface for new module as outlined in label application instructions issued by AAR. Use template as a guide, and apply new module.

(4) Black border area—two inch black border must be maintained. Any rivet heads in this area must be painted black.



NINE ACI SCANNERS cover Peoria & Pekin Union's A and B yards at East Peoria

P&PU has ACI in terminal control

How would you like to invest $1 and earn a return of $3? In essence that is what the Peoria & Pekin Union is receiving from its investment in a data collection system now going into service. Heart of the system is a complex of nine automatic car identification scanners strategically located to record all inbound and outbound moves at P&PU's East Peoria "A" and "B" yards.

"Our new ACI system will make it possible for us to increase reliability of P&PU services, generate greater utilization of equipment and facilities, reduce operating expenses and improve the security of our operation," says P. H. Galloway, president and general manager. The ACI system will scan 4-5,000 cars daily. Additionally, a major benefit will be a 17% reduction in clerical forces for the railway serving the Peoria Gateway, the fifth largest rail center in the nation.

At the entrance to B yard (North End), three ACI scanners will catch all moves including outbound pulls. Similarly, three scanners at the entrance to A yard (South End) will scan all cars moving into and out of that yard. Between the yards, known as the crossover tracks, three more scanners are located to view transfer moves between the yards and internal switching.

Equipment is furnished by ACI Systems Corp., and includes three label decoder processors (mini-computers) which handle the input from nine scanners through a new multiplexing technology. The LDP's (Digital Equipment Corp. PDP-8E) provide message generation, train reversal detection, format control and other optional capabilities. Each LDP is considered to be a 1050 station on P&PU's 1050 teleprocessing network. The network is controlled by the road's central computer, a Honeywell 115, with 32k memory.

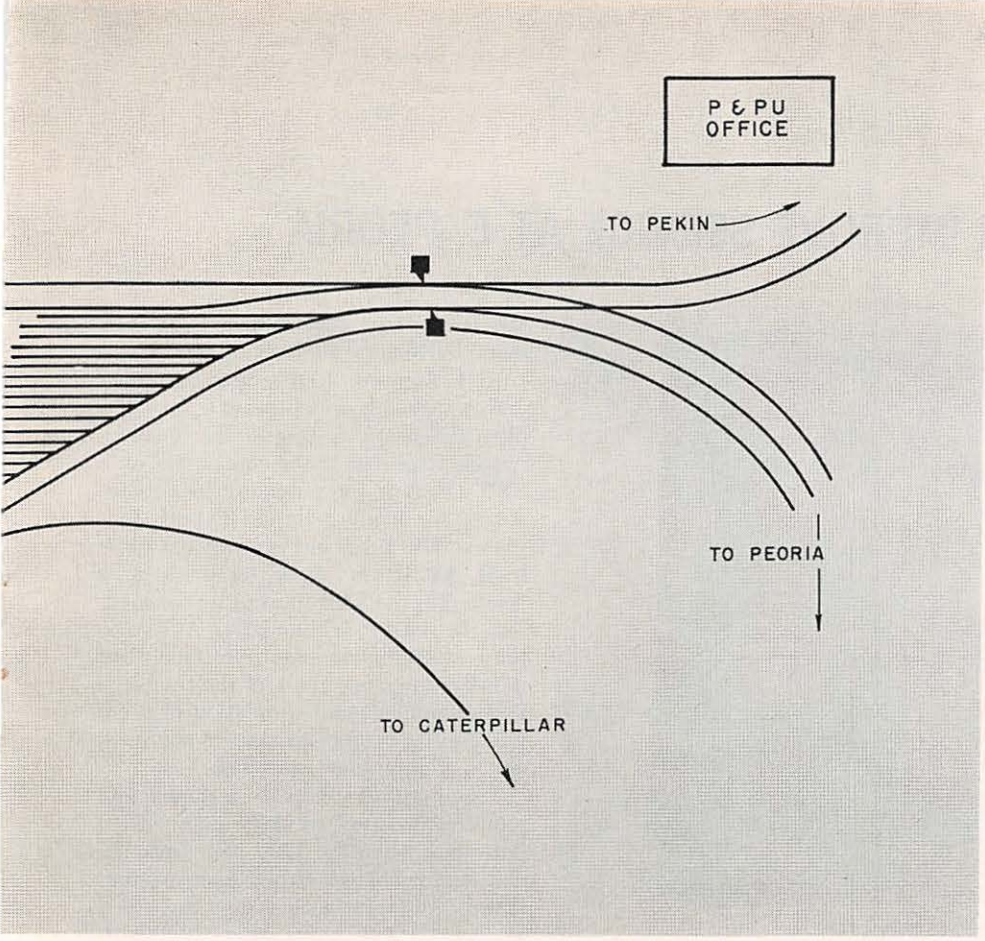
ACI is added to P&PU's present terminal management system, and will provide benefits in the following areas:

- —Yard inventory and yard control.
- —Car accounting.
- —Demurrage and industrial inventory.
- —Rip track control and inventory.
- —Customer service improvements.
- —Joint facility accounting records.

ACI will materially reduce present efforts in keeping yard inventory. The ACI scanners are located on the switching leads, and provide a record of cars switched within or from and to the A and B yards. Previously, such checks were obtained by clerks. Also, every 8 hours a physical check of each forced detention and classification track is made, which can be discontinued because ACI will keep track of cars in and out of yards. The label decoder processors use software routines which produce net scan data output resulting from reverse moves that take place in front of scanners.

Because P&PU is a terminal company owned by Chicago & North Western, Illinois Central, Norfolk & Western and Penn Central, it performs interchange service for these railroads as well as nonowners BN, CRI&P, C&IM, GM&O, IT, PT, TP&W. One benefit of ACI is that it provides the official interchange time for P&PU and the roads it serves. For example, certain tracks in A yard may be designated as "IC tracks" which means that when cars are shoved into these tracks, they are officially delivered in interchange to the IC. With ACI scanning cars, the time of the cars placed onto the IC track is recognized as the official interchange time.

P&PU has a PICL system which is carried in a disc file—all waybill data for a car is carried in the computer files while the car is on P&PU—and ACI provides a match to the PICL file on a car-by-car basis. Until ACI, it was known what cars stood on a yard track, but a physical check had to be made to de-



to record all car moves into and out of these yards.

system at E. Peoria

termine their exact order, which was necessary for making up the owners outbound wheel reports.

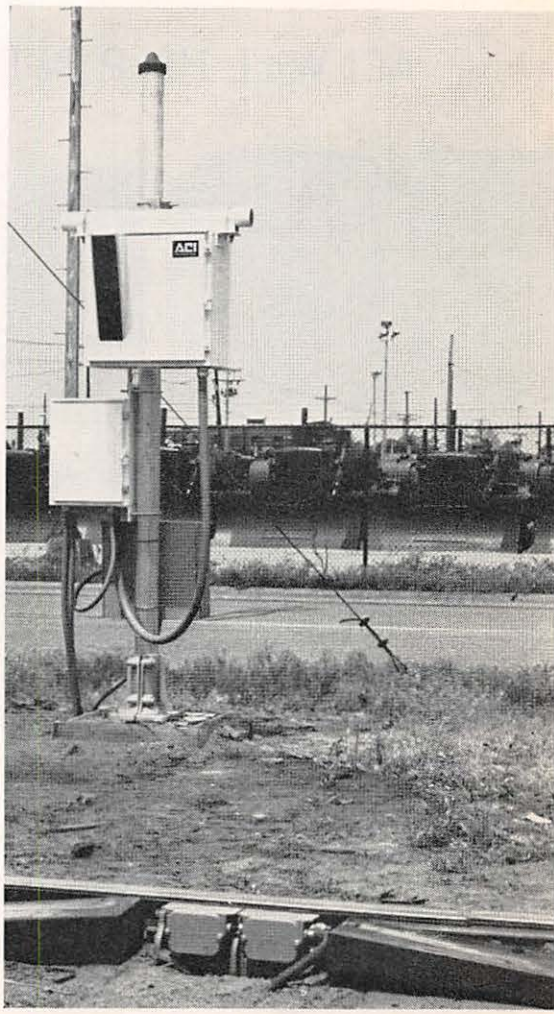
From the ACI-generated data of inbound trains, the central CPU makes up the switch lists. These are sent via the 1050 teleprocessing system to the yardmasters and trainmasters. Equipment will tentatively be installed to have 1050 printouts at switch tender locations at the A and B yards.

P&PU also has an incentive for using ACI to provide time checks on car moves because of the complicated per diem system at the terminal. P&PU receives a handling charge for every car switched, and ACI will provide a more accurate check on this activity, resulting in improved records and revenue.

In the areas of customer service improvements and demurrage ACI will provide benefits to the railway and to one of its major cutomers, Caterpillar Tractor Co. All cars that P&PU delivers to or pulls from Caterpillar's East Peoria plants pass ACI scanners. By agreement, the time and date of the ACI scan is accepted for demurrage purposes.

Additionally, Caterpillar car movement will soon begin using a secondary label application for outbound shipments. Many of these shipments are of the repetitive type. Some have only the destination as the change, and of course the identity of the car, and time and date of the pull from the Caterpillar plant. By agreement between P&PU and Caterpillar, small black and white striped labels—encoded for three digits—will be attached to Caterpillar equipment. The ACI scanner will read the car label and also this secondary label. From information previously obtained, P&PU's computer will prepare the waybill using this scanned information and the repetitive information—such as consignee, consignor, equipment, etc. As a result of this use of secondary labels and ACI, considerable clerical effort on the part of the shipper and railway will be reduced, as well as expediting service. With such technology, outbound shipments are billed on arrival at the yard, immediately classified and depart on next available train.

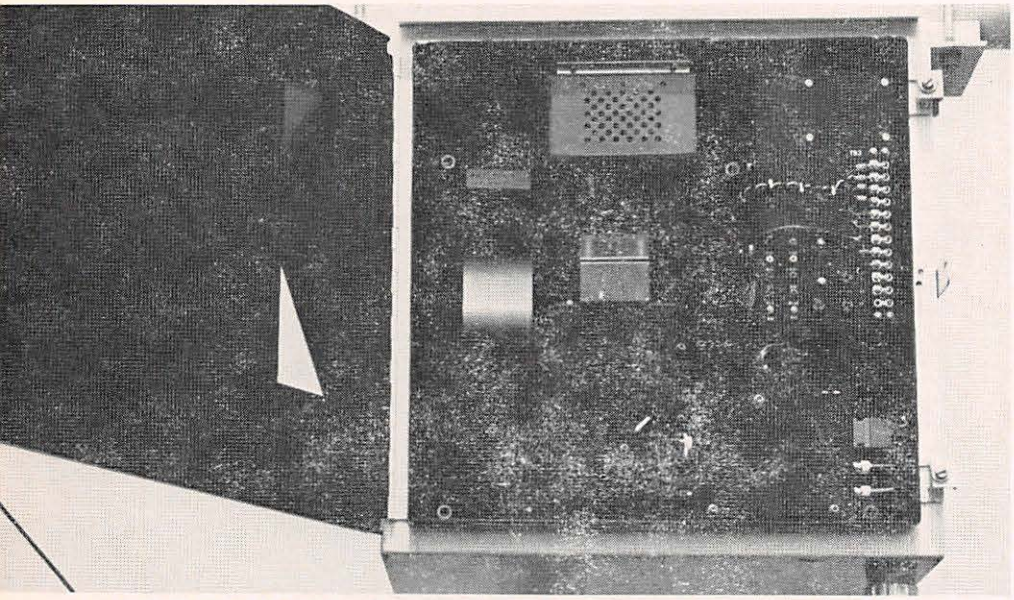
For operational usage, a block code number is assigned to each car arriving on the railway. This number contains "from and to" information, hence is a guide for switch list preparation and any switching that may be required. The block code number is placed on disk files on a random basis hence does not indicate position of the car on a track. This number is maintained in the



SCANNER has two wheel sensors.

CPU is label-decoder processor.

ACI WILL HELP P&PU IMPROVE SERVICE AT E. PEORIA



MODULAR DESIGN is a feature of the ACI Systems scanner.

file until the car leaves P&PU, and then it is deleted from the file.

All inbound cars are inspected by mechanical department forces. If they find a car without an ACI label, it is bad ordered and sent to the rip track for labeling and reported as such. Via the 1050 system, they report the car initial and number to the computer center, where a unique sequence number is assigned to the car. This number is deleted when the car comes out of the rip track and is identified by the scanner. Cars with unreadable labels—determined from ACI scan data are also tagged with this unique sequence number. By using data enhancement procedures involving advanced consists, conductor's lists, physical location and prior identification, P&PU has been able to match this unreadable car label with its waybill data. It's record of matches has been 98% accurate so far. The unique sequence number is carried with the car in the file until the car leaves P&PU. When an unreadable label is identified or indicated by the ACI readout, the original identification of the car can be used to re-identify the car as it moves within and out of the terminal.

"Throughput time for cars through P&PU is now about 24 hours, but we expect to cut this to 20 hours or under with full implementation of ACI," reports L. I. Dillenbeck, supervisor machine procedures. "ACI will be more accurate and thus, we will have complete car records." For example, P&PU prepares a list every 8 hours of the inventory of its yards. Information includes car initial and number, load or empty, tonnage and may include status information such as received, departure from rip track, etc. Two railroads will use this list to determine motive power requirements for trains to and from P&PU at East Peoria.

In obtaining car identification data more quickly, especially for outbound checks, P&PU will materially improve service to four owning roads in which it has a data exchange program. To C&NW, IC, N&W and PC, P&PU is another station on their teleprocessing networks. P&PU transmits data to these roads in their formats. Although it uses the AAR standard format, P&PU's computer is programmed to make the format changes. Also, P&PU receives advance consist data from these roads. It also exchanges data on a teleprocessing basis with the Illinois Terminal.

P&PU leases the ACI equipment including maintenance from ACI Systems Corp. P&PU furnished the housings—6′ by 6′ by 8′—for each label decoding processor and its associated communications interface. The LDP handles three scanners, all located within 1,000′ of the building. Multi-conductor cable handles communications to and from each scanner, power for the scanner and power for the overlay track circuits that provide a four second turn-on for the scanners. The track circuits—about 100 ft long—are the series overlay type made by General Railway Signal Co.

ACI Systems LDP's are equipped with test panels which provide for complete diagnostic testing at the location. A jack is provided for connection of a KSR Teletype for providing local readout or for loading the LDP with programs. The programs are written in 8-level ASCII on paper tape which is inserted in the KSR transmitter for loading the LDP. Additionally, ACI Systems communications interface test panel permits operation of the track circuit equipment and simulation of a car passing the scanner to make a complete check of equipment operation.

Plug-in timers displaying hours and minutes are used to alert maintenance personnel when the 1200-hour time has elapsed for changing the Xenon scanner lamps. Although such lamps are rated at over 2,000 hours, the 1200-hour changeout assures high intensity scanning.

The LDP's presently are equipped with 4k core, but can be expanded to 8k or 12k. Present capacity is 400 labels, but could obtain 1200-label storage capacity with an 8k core.

Two Siemens wheel sensors are provided at each scanner location to provide wheel count and direction. The latter is important for providing net scans where reverse moves are made, and also at one scanner location provides identity to moves coming from other railroads.

In an experiment to determine accurate yard inventory on all yard tracks using wheel sensors. P&PU will be working with ACI Systems Corp. and Abex Corp. on an installation with wheel sensors on five tracks of B yard. Admittedly, at the present time, an incorrect throwing of a switch will cause a misroute, which can not be detected by the current ACI system. However, with wheel sensors on each track, identification of a car initially in the switching process and subsequent wheel detections will provide monitoring ability into a specific track.

"ACI is making it possible for us to develop a number of valuable reports and services, including inventory of cars to and from connecting lines; switch lists; joint facility accounting; demurrage accounting and protection for industries; and performance of car repair facilities . . . to name a few," says Galloway.

FCC News

SP participates in oral arguments before FCC

All seven Federal Communications Commissioners were present when oral arguments were held concerning the possible entry of other than the telephone and telegraph companies into the specialized common carrier field in the point-to-point microwave service. The following is abstracted from *Telecommunications Reports:*

Herbert Forrest, counsel for Southern Pacific, noted that "it may be reasonably anticipated that through appropriate interconnection with compatible systems, Southern Pacific will participate in the offering of specialized communications services which will be nationwide in scope."

The SP counsel was the first of a number to refer to the address last year by New York Telephone Co. president William M. Ellinghaus which announced that the Bell System plans a nationwide digital system by the mid-1970s. This talk, which can now be referred to simply as "Ellinghaus' New York Address" with instant identification in the trade, was later termed by George E. Ashley, general attorney, American Telephone & Telegraph Co., as simply a public confirmation of developments which the Bell System has been working on for many years.

Forrest, who was the first to ask the FCC to call on AT&T and Western Union to produce their forecasts of the data market, observed that "Neither carrier has come forward with the data . . . Southern Pacific submits that the carriers should be stopped from asserting that the record is inadequate to support a finding of need for the communications services which they have failed to meet."

Noting the variety of reports and other statements urging competition in the telecommunications field, Forrest termed this a "tide which is now at the flood stage." He keynoted that "How many carriers a particular route or area will support is a judgment which should be made not by the Commission . . . but by the economic forces of the market place." He added that "In the light of the substantial expenditures involved, it may reasonably be anticipated that those applicants who do not believe they can successfully compete in the market will not enter the market."

Finally, he recommended that "a series of informal conferences be held, under the auspices of the Common Carrier Bureau, to resolve any issues of frequency conflict, principles of interconnection, compatibility of systems, possible consolidations, and any other issues which may be resolved more expeditiously without a hearing."

Richard P. Taylor, for the Greyhound Corp., was questioned by Commissioner Robert T. Bartley as to his references to improved service, and as to whether he really was referring only to economics. Taylor said he meant both. He said that Greyhound's survey of the Southern Pacific Communications Co. plans indicated that it would provide several maintenance and operational features which would improve the service his client is getting.

Commissioner Nicholas Johnson appeared to attach some significance to a "yes" answer by Taylor to a question as to whether a reference to private line voice service meant an alternative to public message toll telephone service. The Greyhound counsel came back to emphasize that he was talking about possible new uses of voice, and not diversion from message toll telephone.

Commissioner Robert Wells wanted to know if Taylor meant that the service Greyhound is seeking is physically present, but not economic. As a rule, Taylor responded, this is true.

FCC announces policy of free entry for newcomers

By a unanimous vote of the seven commissioners, the Federal Communications Commission, on May 26, provided free entry in interstate private line and specialized common carrier services with price regulation to come largely from the forces of competition, rather than the constraints of a regulatory agency. The following is abstracted from *Telecommunications Reports.*

The Commission told the established common carriers that they are free to compete with the new entrants, provided they do not engage in cross-subsidization of competitive services by those in the monopoly category—a dwindling group which still includes message toll and wide area telephone service, and public message telegraph service, by the FCC's reckoning.

It said that "Where services may be in direct competition, departure from uniform nationwide pricing practices may be in order, and in such circumstances will not be opposed by the Commission."

In essence, the FCC wound up most of the major policy issues in its specialized common carrier inquiry with a "grant them all" policy. As long as the pending applicants meet the basic technical and financial qualification requirements—which presumably virtually all of them do—and can clear their proposed sites so that no harmful radio frequency interference is indicated, their requests will be granted as soon as FCC processing can be completed.

Implying no present intention of appealing the ruling to court, the American Telephone & Telegraph Co. declared that "We are pleased that the FCC has stressed that we may compete fully in providing the specialized services and that the guidelines for competition will be the same for all competitors—the new specialized carriers and the existing carriers alike. We have been urging that all along.

"We are also encouraged that the Commission has recognized that it may be in order for us to depart from uniform rate averaging in pricing directly competitive services. Under such circumstances, we are confident of our ability to compete vigorously and effectively."

Russell W. McFall, Chairman and President of the Western Union Corp., was quoted as saying that "We welcome this competition on the basis that competition means freedom of pricing and freedom of deployment of resources. We understand that the decision will allow Western Union, as an established common carrier, to adjust rates more freely than in the past, to meet competition from the new specialized common carriers."

Taking up the five basic questions of its inquiry into specialized common carriers, the Commission came to clearcut rulings on three of them: affirming the general policy of permitting entry of new carriers; flatly ruling out comparative hearings on claims of economic mutual exclusivity; and amending its rules as necessary to resolve issues of possible frequency interference and route blockage.

It said the record does not afford an adequate basis for decision of the fourth basic issue—assurance of quality and reliability of service to customers of the new carriers—and said a planned further notice of rulemaking will cover that issue.

As to the fifth, what sort of local distribution service will be required, the FCC said it will issue "as soon as possible" a notice of proposed rulemaking on the frequency band or bands to be employed in specialized carrier-operated local distribution service. At the same time, it emphasized the view that the established carriers should provide local interconnection to the communities in which they operate.

FCC rule would permit sharing

If FCC rules are revised as proposed by the Commission, one private microwave system licensee can permit the use of communications in his system in exchange for the use of comparable communications channels in the microwave system of another private microwave system licensee.

Present rule provisions, it was pointed out, permit microwave sharing on two basis: without charge to the paticipants, or on a "non-profit, cost-sharing" basis. Under the latter, each participant must file an annual report with the Commission showing the cost of operating the shared system, and the breakdown of the pro rata contributions.

Telecommunications Reports states: Since the adoption of the present regulations in 1966, private microwave system licensees have "found it advantageous to enter into agreements under which one permits the use of communications in his system in exchange for the use of comparable communications channels in the microwave system of the other." This arrangement is termed "mutual" sharing.

The FCC, by a 7-0 vote, took the position that these arrangements "have obvious merits, both in terms of spectrum economy and fuller utilization of private systems, and in terms of economy and convenience on the part of the parties."

But, it said, a showing by a licensee that "the monetary worth of the use of microwave channels that it would receive does not exceed that of the microwave channels it would furnish is inherently difficult, if not impossible, to make. . . . In view of the nature of these arrangements, it appears that no useful purpose would be served by requiring strict compliance with the cost-sharing provision of our rules."

The proposed amendments to all private microwave services' rules "would apply only when the consideration given a licensee of a microwave (or other fixed system) by a prospective shared user is the reciprocal use of the latter's facilities by the licensee." FCC added, "If additional consideration is involved, such as contributions to a licensee's capital and operating costs, the provisions of the existing rules relating to the sharing of costs would apply. However, where the prospective sharing user is to supply, at its own expense, the equipment necessary to implement the sharing arrangement, such as multiplexing, receiving equipment, connecting lines, etc., this would not be considered as additional consideration and the cost-sharing provision would not apply."

FCC's PBX group names task force leaders

Two chairmen have been named to the FCC's PBX Interconnection standards' subcommittees. Robert Y. Sims, International Telephone & Telegraph Corp., heads the subcommittee on procedures and enforcement. John R. Wheeler of Xerox Corp., and representing the Electronic Industries Association will be chairman of the technical standards subcommittee. Chairman of the FCC advisory group is FCC Commissioner Thomas J. Houser. Bell System, according to *Telecommunications Reports*, has distributed a glossary of technical terms to the members.

SP supports FCC on microwave sharing

Southern Pacific Transportation Co. supports a Federal Communications Commission proposed rule change which would permit mutual, or reciprocal, sharing of each other's private microwave operational fixed stations by FCC licensees. SP said it needs to share such facilities to operate its TOPS (total operations processing system), and in fact now shares with two other railroads under other sections of the FCC rules. But, it noted, the present rules do not specifically provide for mutual, or reciprocal, sharing, and such arrangements must be made under the cost sharing provisions of the rules.

NEWS BRIEFS

BN to begin work on Northtown class yard

Burlington Northern will shortly begin work on its new $30 million Northtown automatic classification yard at Minneapolis, Minn. The new yard will have 64 classification tracks and will be operated by a process control computer.

Noise control will be considered in the design phase, not heretofore often recognized. Retarder squeal is the problem. Solutions under consideration include the use of sound dispersing acoustical barriers at the main and group retarders; installation of longer retarders which would require less shoe-to-wheel pressure; and use of softer-metal, faster-wearing retarder shoes.

SP to construct new automatic yard

A $39 million, 48-class track automatic yard will be constructed by Southern Pacific at West Colton, Cal., 50 miles east of Los Angeles. "Technological innovations in the yard will improve our service and efficiency," says Benjamin F. Biaggini, SP president. "Computers will control the speed, braking and switching of cars, maintain a continuous inventory of all tracks, and provide reports to management. Advance planning for the makeup and movement of trains will be improved."

Other technological improvements will include automatic car identification, electronic weigh-in-motion scales and closed-circuit elevision.

L&N will install hotbox detectors

Louisville & Nashville's Board of Directors has approved plans to install more hotbox detectors with wayside display boards on mainline tracks between Birmingham and Montgomery; Mobile and New Orleans; and in the Evansville-Nashville-Memphis region.

Also approved are plans to construct 75 new steel, radio-equipped cabooses at South Louisville shops.

Japanese railroad orders Univac computer

Kinki Nippon Railway Co., Ltd., has ordered a $4 million Univac 1110 computer system. It will supplement and enhance three existing Univac 418-II systems used by Kinki Nippon for real-time, automatic reservation systems covering express trains, tourist buses and hotels.

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Designed to operate with a standard SERVOSAFE® Hot Box Detector System, the SERVOLARM visually signals the presence of a hot journal box and also pinpoints its location by means of a digital readout axle count. SERVOLARM helps to eliminate train stops and crew delays. It simplifies and speeds up the entire hot box location procedure by directly notifying the crew via a trackside display board.

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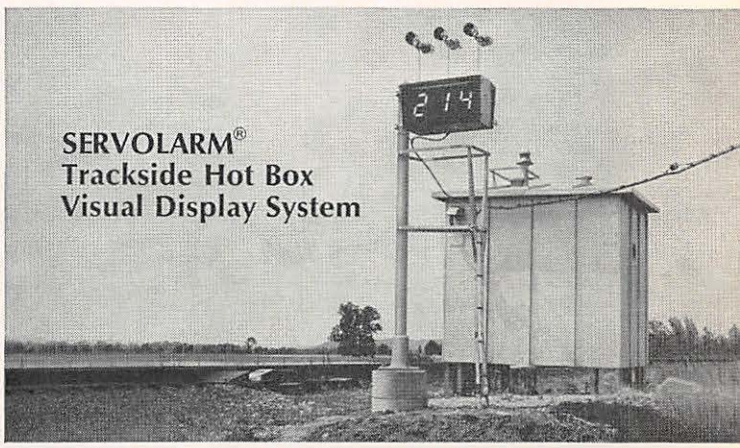

Bi-directional display board presents digital readout, showing axle count location of hot journal box. If no hot boxes are detected, display board reads "000". Flashing signal lamps on top indicate presence of hot box.

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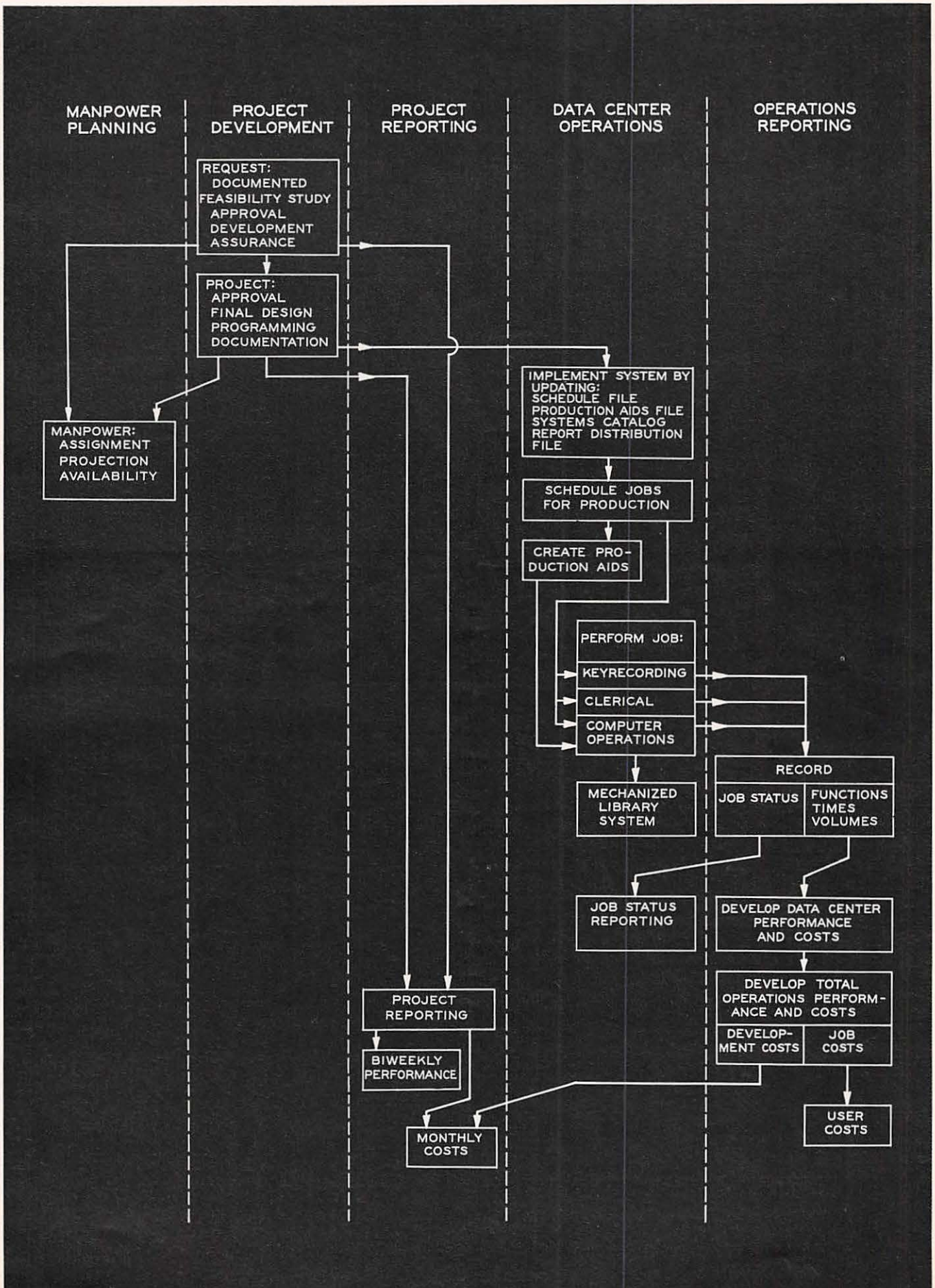
MEMBER RPI

Circle 21 on reader service card

How to manage a complex of seven

COMPUTERIZED CONTROL SYSTEM schematic shows organization for large scale data processing.



railroad data centers

For many railroads, data processing management is relatively easy because all computers are centralized at the headquarters. But things get a little "sticky" when a railroad has several computer centers. Managing to obtain the most efficient use of all computers can be a problem of giant proportions. Penn Central, for example, has a systems development department consisting of over 1,000 people supporting 21 computers installed in 7 data centers. About 6,000 active programs are on file and tape libraries contain 47,000 reels. Annual departmental expenses including data communications network and telephone facilities, exceed $20 million.

"Obviously, managing this complex effort is a formidable task. Our departmental management philosophy is focused on: (1) selection of new profitable projects; (2) control of project development and operations; and (3) evaluation of systems performance," stated George A. Kessler, director business systems, Penn Central, in a paper delivered at the Third International Symposium on Railway Cybernetics.

Abstract of the paper follows. Requests by a using department are formalized through the preparation of a Request for Systems Development, and assignment of a unique project number. Proposals are evaluated at regular systems development staff project reviews. Projects with favorable benefits are approved for development of a feasibility study. The results of this study are summarized on a form, Authorization for Systems Development. At this point, the technical, operational and economic feasibility of the project have been established and affirmed through a Feasibility Assurance meeting. The project is evaluated for return on investment using a discounted cash flow basis. A final staff review paves the way for approval for final systems design, programming and implementing the system.

All productive personnel involved in the development and maintenance of systems are required to make a daily accounting of their time by project and major function. This data is accumulated by project manager, and cards are keypunched to record the developmental efforts. Other data is abstracted from the above mentioned systems development project forms, combined with the development data, and processed through a series of computer programs to produce periodic management reports. These include weekly reports produced to display project and departmental status, maintenance efforts. A monthly report will introduce dollar costs into the picture to provide the necessary economic measure of incurred vs. estimated project development costs. A by-product is the separation of expensed and capitalized efforts.

A manual sub-system provides for developing manpower availability by type of personnel, projected from present assignments and future commitments.

These reports have been an invaluable tool for the management of the department, since they clearly identify present status and future capability and requirements.

Those who have had experience with a multiple computer installation and a large data library are well aware that a lack of uniformity and orderliness in operations can lead to chaotic conditions. Manifestation of such situations are excessive reruns and loss of valuable computer and personnel time. A comprehensive control system is mandatory in such a situation, for the only other alternative is to overpower the problems with additional hardware and people at, what can be, astronomical costs.

Optimizing the computer

To us at Penn Central, the path to be taken was very clear. The control systems I am about to describe have proven to be extremely effective in optimizing our computer operations.

Before a new application can be implemented, it must be set up for operations by an implementation group. This group introduces the job into the several computerized operational control systems.

Our largest data center at Philadelphia has a multiplicity of jobs on numerous different schedules creating a very complex scheduling problem, which cannot be handled manually in an efficient, reliable manner. To assist us in this task, we developed an automated scheduling and production control system. The heart of this system is a magnetic tape master file established by the implementation group. This identifies the key processing steps in each active job and their scheduled frequency of occurrence. Each month this file is processed to produce a monthly schedule tape, geared to the calendar for that month. From this tape, there is printed a complete monthly production schedule and separate due-in reports for each of the center's eight control stations. Schedule cards are produced for each key job step and are distributed to the appropriate control station. As work is received and released, actual dates and times are posted on the schedule cards. Cards for completed tasks are collected each day and processed against the master schedule file to produce a job status report. Thus, jobs behind schedule are identified immediately for corrective action to be taken. The posted master tape is printed after the close of the month to obtain historical performance data. This is very useful in establishing future schedules and identifying critical areas or processing periods.

Supplementing the scheduling system is a secondary file used to print a Report Distribution List. This displays each scheduled report by name; and identifies the frequency of preparation, the number of parts, the addressees and the mode of delivery. The system also produces gummed address labels as needed. This simple tool is a valuable aid to our input/output group in the distribution of the many reports produced each day.

The automatic scheduling system is linked to another vital component of our total control package called production aids. This link is via a printed record called the chart schedule and an associated deck of daily job call cards created by the scheduling system.

Creation of the master file for the production aids is another task of the operations implementation group. They review the documentation for each new system prior to installation, and prepare master data identifying each program and input or output file processed by the system. This data is used to update a master charts and labels file. The latter is used by the job schedulers in conjunction with the daily prepunched deck of job call cards. The schedulars line up work for processing by assembling the call cards in the order the jobs are to be processed. The system provides for the introduction of variable data such as changes in file retention, identification of work periods or other comments. The job call cards and variable data is processed with the master charts and labels file to produce the three working tools of the system. These are: the computer operations charts, external tape or disk pack labels, and prepunched library cards. The computer operations charts identify each program in the job stream with

Production controls aid evaluation of computer performance.

their associated files, inputs and outputs. Space is provided on these charts for the manual entry of permanent reel or disk pack serial numbers. These are entered by the operator as the files are created.

A pre-printed pressure sensitive external file label is generated for each file to be created in the job stream. This label carries the file identification, the creation date, retention period, scratch date, and final disposition, along with appropriate remarks to clarify handling. Multiple labels are created automatically for files extending over two or more reels. Scratch dates are precomputed from the retention period carried in the master file, thus practically eliminating the possibility of early scratching of files.

After the production control group posts input reel numbers to the new operations charts, the job aids package is sent to the library for pulling the input files required. The charts, labels, and tapes are then released to the computer room for the job run. Labeled tapes and disks, as well as charts from completed runs are returned to the library. Here, the prepunched library card created for each label printed during the label run is matched with the completed file. The physical reel number is keypunched into this card. Completed cards are read to tape for updating the master library inventory file. This master is printed periodically to identify files required for future processing. A listing in reel number order is used to take periodic physical inventory of the library. Regular listings are created in job responsibility order; these are used to review the files held in a permanent retention status to release those no longer needed into the active tape inventory. With over one hundred analysts retaining data on tapes, this has been an invaluable tool in minimizing our physical reel requirements. A unique feature of this system is the ability to introduce a single action control card to release for scratching entire blocks of tapes held under a common file identification. Another is the automatic incrementing of scratch dates when jobs are several days behind their normal processing schedule. The accuracy and control we have obtained through implementation of these interrelated systems is nothing short of amazing.

Now that we have dispensed with the tools for implementing and operating new and changed systems, let us turn to the problem of evaluating our operating performance and costs. The key to all of our controls is a uniform technique for numbering each project and functioning system with a six character code. The first two alphabetic characters designate the application area for example, PR designates payroll. For a new project under development, the letters are followed by a "D" and the last digit of the year the project started. The final two digits are a consecutive number indicating the sequence of the projects started in that area that year. Thus, PRD003 indicates the third project started in the payroll area in 1970. In the case of a functioning system, the two digits following the area designator represent the job number in that area while the last two digits represent the consecutively numbered steps within each job. Thus SA7102 is a step in a job for the Safety Department (SA) concerned with personal injuries (71) and specifically is the quarterly listing program (02). Each human or machine effort spent on a new project or on a production job is identified by its appropriate number. All functioning production systems (or jobs) and a brief description thereof are identified in a departmental systems catalog. I cannot overemphasize the need for a meaningful, uniform job numbering system.

Since all information systems must start with data input, our initial effort to evaluate performance was for our key driven input devices. In this area we elected to establish engineered standards based on Time Measurement Units. Many of you are probably familiar with this concept of using incremental standard times to build unique standards for a particular work function. From the data in several publications on this subject, we developed a formula which establishes for each input record a numerical goal of recordings per hour, which we call a target. Construction of the target requires a statistical analysis of the keystrokes necessary for each type of input record. This analysis of actual records is performed by a computer program. The analytic data generated, together with a coded description of the source document and the machine functions, are fed into a second program. The latter computes the production target which reflects the number and type of keystrokes involved, the legibility and handling of the source document, and the type of input terminal used.

Keyrecording operators are required to prepare a job card for each productive and non-productive function. These cards show operator identification, function, start and stop times, and records produced. They are keypunched and processed through a series of programs to produce a weekly operator performance report for use by supervision at each center. Performance is measured on the percentage relationship of standard hours (volume ÷ target) to actual hours, and individual operator performance for the prior four weeks is displayed with the current week, to indicate trends. The weekly data is consolidated monthly at each center, and the center's keyrecording costs are introduced into the processing. The result is a monthly job oriented report which shows job performance by operator, time and dollars expended on each job in the center, and an analysis of productive and nonproductive time.

During the preparation of this monthly report at each center, a tape is created for wire transmission of key summary information to our headquarters in Philadelphia. Here data from all centers is consolidated for preparation of a monthly performance summary for our director of data center operations. Since each center utilizes a common numbering system, we are able to consolidate volumes, hours and costs by individual job. From this sophisticated system:

(1) We have gained the ability to theoretically evaluate cost/performance characteristics of various input devices, enabling us to obtain the most economical hardware mix.

(2) We are able to identify operators performing below desired levels and can take steps to upgrade their performance through counselling and training.

(3) Actual distributed costs are available on a consolidated basis for assignment to the department being serviced.

(4) Readily available volume, hours and recording costs for each type of input permit rapid evaluation of new technology for inputing data.

(5) Performance percentages by job permit identification of locally developed techniques for improving efficiency and give indication of areas where improvement can be obtained.

(6) Performance ratios for entire centers serve as a measure of management effectiveness.

(7) Non-productive time and its cause together with its relationship to productive time is available for each center and in total for analysis and implementation of corrective measures.

In brief, we have a comprehensive measure of where and how effectively approximately 365 data recording personnel are exerting their efforts.

Since every system has each function identified by a unique step number, we are able to use the keyrecording programs to develop performance data and costs for clerical and auxiliary steps. This is accomplished by having the individuals involved record the time spent and volume handled on these efforts. Labor costs for these clerical cost centers, available from our corporate responsibility accounting system, are distributed by job on the basis of productive hours expended on each job step.

The final and largest area of costs to be identified, controlled, and distributed are those generated by the computer operations. Here again the base for all reporting is the operator's recording of machine usage. For each job processed; we record job/step number, the external clock start and stop times, central processor internal meter start and stop times, operator number, and the use or function code. For computer systems operating in a multi-programming environment, this data is recorded internally for each operation taking place in a partition. Each 12 a.m., recordings are closed and cards are punched from the console records to prepare a daily utilization list. This list, in chronological order by machine, sums up for each computer system; the lapsed and functional time and percent relationship, and the number of programs processed during each 8-hour shift and for the complete day. This report is available to the center manager on the next day, so he can review his operational efficiency and pinpoint operator or machine problems. Since the percent of meter hours to lapsed hours is computed for each program, runs having excess non-productive time are quickly identified. We plan to retain these daily detail records for end of month computerized consolidation. Machine rentals, labor, and overhead charges for electricity, air conditioning, general supplies, etc. will be introduced into this processing for distribution to all use codes except idle time. The detail will be sorted and summarized by job step and job. Machine room costs are charged to a job/step on a lapsed time used basis. Costs for systems operating in a multiprogramming environment are distributed on a basis of time and resources used. Since the job coding structure permits automatic identification of regular production, developmental runs (assemblies, compiles, tests, etc.) and internal control systems (production aids, library system, machine utilization, etc.) we can categorize the jobs accordingly. Thus, each manager will know on a monthly basis how long each job took, how much it cost; and how much effort was on developmental work, internal controls or was lost because of re-runs.

During the preparation of this monthly consolidated report, a magnetic tape will be produced at each data center. Job cost/performance data on this tape, wire transmitted to the main center at Philadelphia, will produce a consolidated cost report by job and center. Here again the use of the common job numbers at all centers permits the summarization of like jobs to develop total hours and costs.

Our data systems cost philosophy on Penn Central is to have no costs chargeable to ourselves, that is, all departmental costs are ultimately identified with the departments we service. Thus, our next step is to process centrally the separate data sets representing analyst costs for systems development; and costs of data recording, clerical efforts and machine operations, to consolidate cost data by developmental project or functioning system. At this point in time, all costs which have been directly associated with each data center's internal control procedures, as well as costs of reruns resulting from errors or failures ,are converted into a general overhead cost category. This overhead is re-distributed on a cost prorate to all productive jobs involved, that is, if a job accounts for 2% of the total costs of the productive processing, it receives 2% of the distributed overhead. This consolidated data is matched against a cost responsibility master file, which identifies the using department for whom the job is performed. If a job is associated with several using departments, each department is allocated an appropriate percent of the cost of this particular job they will share. The end result is a totally distributed computer cost tape, which represents a 100% chargeout of all computer operations to the user. A final list produced from this run shows individual user responsibilities, development costs incurred by project, and operational costs by job.

Each project under development is monitored. Costs are automatically compiled from the several sources of origination. For ongoing systems, operator and machine performance is displayed for evaluation. Operational costs of newly implemented systems are generated automatically thus permitting quick comparison with original estimates. Sources of overruns are easily pinpointed. Since the system automatically generates true hourly costs by type of machine, a sound basis is provided for estimating costs of future projects.

In summary, by designing a "closed loop" total system, we have made full use of the power of the computer to monitor its own performance.

Use power of computer to monitor its own performance.

People

Richard C. Shoppert
ACI Systems Corp.

James D. Greer
McGraw-Edison

B. R. Merta
McGraw-Edison

Frank A. Scott
General Ry Signal

Joseph V. Hoffart
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ACI SYSTEMS CORP.: Richard C. Schoppert, formerly manager marketing services, Illinois Central, appointed regional marketing manager, with headquarters in Chicago.

EDISON BATTERY DIVISION, MC GRAW-EDISON CO.: James D. Greer, southwestern district manager at St. Louis, Mo., appointed southwestern regional manager, there. **B. R. Merta,** eastern district manager, appointed eastern regional manager with headquarters in Bloomfield, N.J.

GENERAL RAILWAY SIGNAL CO.: Frank A. Scott, assistant eastern sales manager, New York, appointed district manager at Boston, Mass.

HALLICRAFTERS CO.: Wilford C. Shurtleff appointed manager, land mobile marketing.

MARQUARDT INDUSTRIAL PRODUCTS CO; Joseph V. Hoffart, regional marketing manager communications, appointed marketing manager communications products. Offices have moved to Suite 110, 1001 East Touhy Ave., Des Plaines, Ill. 60018.

OKONITE CO.: Donald F. Schwamb, Jr., district manager, Portland, Ore., transferred to Chicago. **John F. Coyle,** sales representative Portland appointed district manager there. **Raymond V. Montagno** appointed sales representative, Chicago.

SIGNAL & COMMUNICATIONS DIVISION, WABCO: George F. McGlumphy, manager systems analysis, appointed chief engineer, computer systems.

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Editor's Corner

Rails' ASTRO program needs your help now!

Now is the time to let your Congressmen know that you support the Association of American Railroads' ASTRO (America's Sound Transportation Review Organization) program. Of interest to railroads—and their employees because healthy, successful railroads can provide well-paying jobs—are bills now being considered by the U.S. Congress. Several have the same end result, that of providing more freight cars. One version would set up a government corporation to buy cars for lease to railroads or to go into partnership with railroads to obtain freight cars. Another key bill would restore the 7% investment credit which did so much a few years ago to spur railroads into buying freight cars, and also locomotives.

A letter writing campaign now to Congress will be most helpful to assure the men who make the laws that you want them to be passed. Don't wait for others, because they may well be supporters of railroads' competitors who desire government funds or support for their forms of transportation and not the railroads.

ASTRO WANTS FAIR TREATMENT

ASTRO recommendations are keyed to six basic areas:

—The federal government should provide relief from local property-taxation burdens, assistance in rail-highway grade-crossing programs, aid in right-of-way modernization and assistance in equipment supply.

—Railroads should be allowed to price their services in line with economic and competitive reality, regulatory delays should be reduced through reforms in administrative powers.

—The law and the regulatory process should encourage management initiative. Creation of "total transportation" companies should be permitted, sound rail mergers should be encouraged, and the path to abandonment of little-used lines should be eased.

—Federal research and development efforts related to rail transportation should no longer be allowed to lag behind R&D efforts involving other forms of transportation.

—Federal policy with regard to rail passenger service should be based on "fairness and realism."

—Rail management and rail labor must make their own positive commitments to the future.

ASTRO's estimates of 10-year capital needs pegs the annual spending far above that which railroads have been able to maintain. Freight car requirements are set at $18.6 billion, locomotive programs at $5.95 billion, rail and tie needs at $5.8 billion, and requirements for other roadway and structures programs at more than $6 billion. Thus, annual spending in the 1970-1980 years should be about $3.5 billion. This is about $2 billion annually more than railroads are presently spending. The difference could come from federal assistance programs through guarantees for loans, grants in aid, or through federally funded corporations to lease equipment to the railroads.

DON'T BE SILENT MAJORITY

If you think that by being the "silent majority" the problem will pass, or you can't do anything about it, don't be fooled. There is evidence that people writing Congressmen have gotten action in such areas as environmental control, consumer protection, education and safety.

The problem of railroad declining earnings and struggle to survive could lead to the ultimate fate—nationalization. This would cost the U.S. government (ultimately the taxpayer) some $60 billion. This price, say experts, is the value of railway plant, equipment and land. To pay less would be confiscation.

Even with the government taking over the railroads there would still be the need for some $36 billion for capital improvements, so the total outlay for nationalized railways might well reach $100 billion. One side thought on nationalization: if you own stock in a railroad company, would you be willing to exchange it for government bonds? For the small investor, most government bonds do not pay as high a rate of return as the prosperous railroads. And if you received bonds, could you sell them for enough to put the money into other securities that would pay as well as your railroad stock?

Back to the main point of this editorial. Now is the time to make your views known to your U.S. Senators and Representatives.

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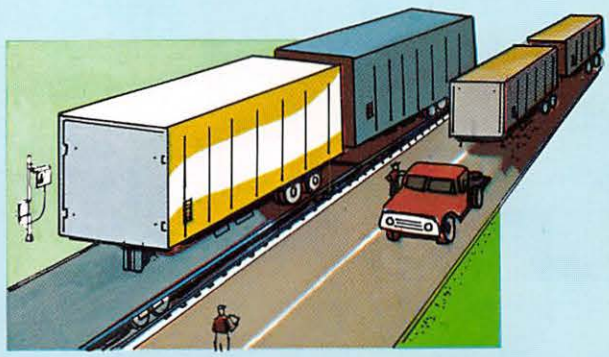

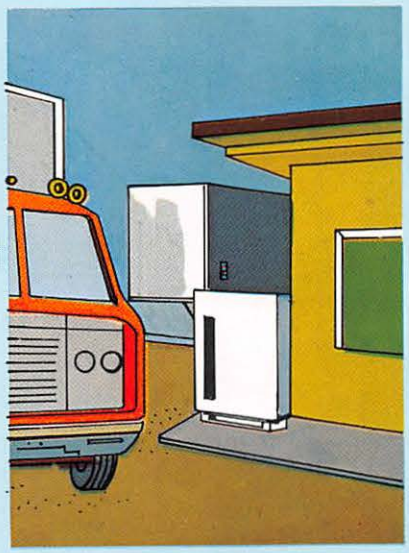

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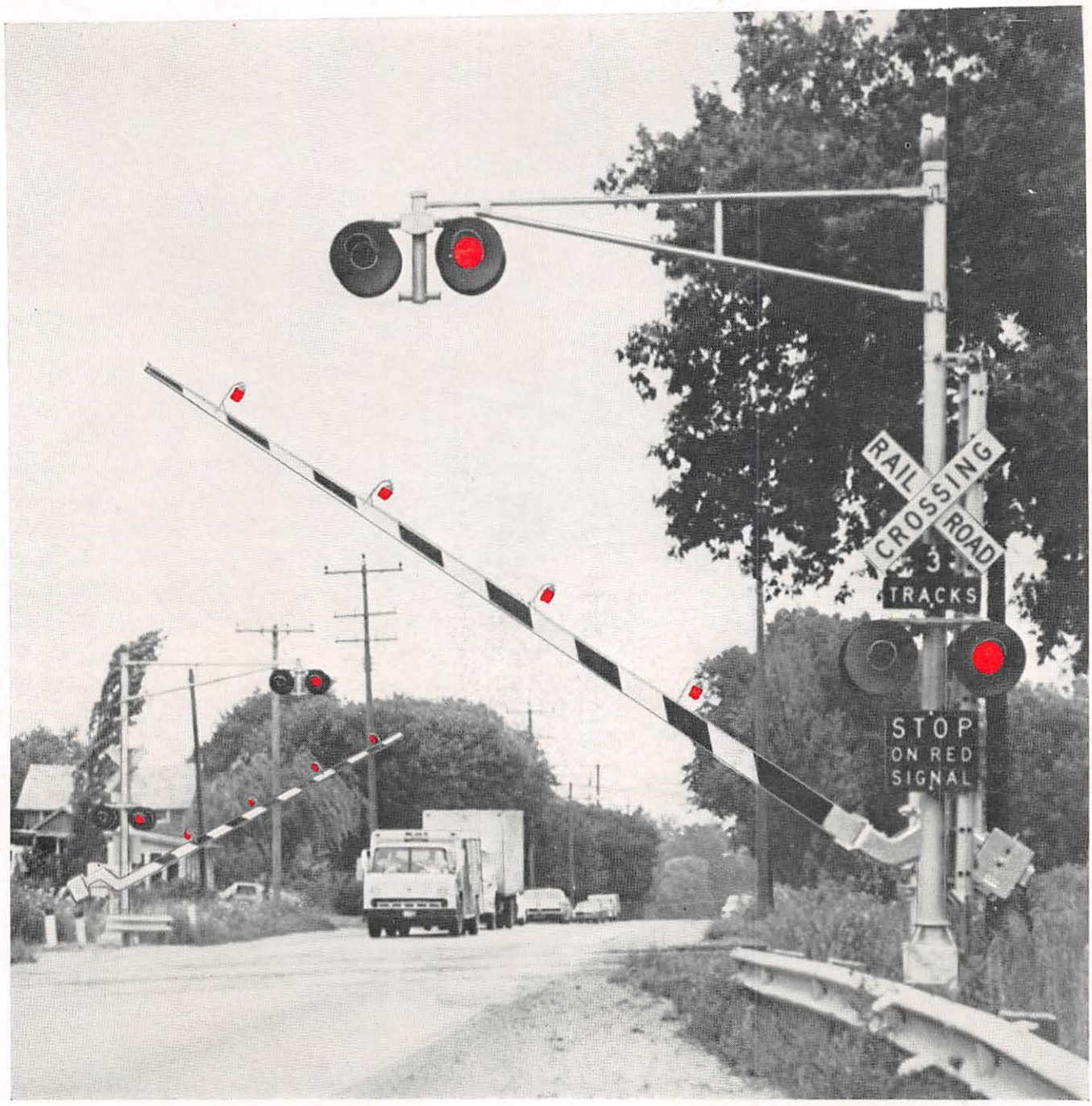

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